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REFINER
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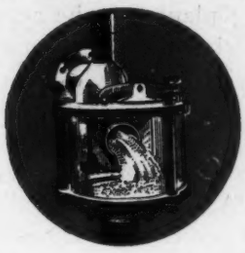

The Look Box

WE are not taken in by the crys of "wolf" in conjunction with the present inactivity or business recession. At best he is but a "diminutive chum" of a wolf and his passing on into the limbo of after-life is surely scheduled for the early spring of this year. Compared to the big bad wolf of song and story of just a few years back, this wolf is but a puppy, and a lean and scraggly pup at that. His future is not only dark but short—unless it becomes quite impossible to untangle the political-economic cyclone at the seat of the government. "Main Street," it appears has become determined to do much toward attending to that, and "Main Street" once aroused becomes a powerful factor. It has been aroused.

Wolf

All years in the business of petroleum refining, witness as slackening of demand for petroleum products during the winter months. In September a portion of this space was given over to a mild warning that after Labor Day gasoline demand and demand for other petroleum products save the fuel oils, would, as usual, slacken. Further, the winter months usually witness a marked decrease in construction work and the letting of contracts, but plans go right ahead for improvements and additions to be erected in the spring. These conditions always bring about the birth of a small "winter wolf" each year. This year the size of the wolf was aggravated by the eratic ticker tape at the exchanges. But, it is felt, the wolf is of no more real importance to this refining industry specifically, than any normally whelped "winter wolf" of many past years.

So much for the wolf. Now look at his poison.

MOST of our students of economics and of business agree that motor fuel demand during 1938 should be somewhere between 5 and 7½ percent greater than the all-time peak demand of 1937. Demand for the various fuel oils this winter is greater than previous years and there is sufficient evidence at hand pointing to a continuation of the adoption in even greater numbers of oil burners during 1938, which augurs well for a large demand for fuel oils next winter. Increased sales of new automobiles throughout the world during 1938 not only point to the motor fuel demand increase mentioned above,

Poison

but also to greater need for lubricants, both oil and greases. Likewise resumption of general industrial activity, confidently expected by many, will restore or perhaps increase demand for lubricants in that phase of business. Wars, whether we like them or not, mean increased demand for virtually all oil products.

Those in close contact with the processing facilities of the petroleum refining industry are fully aware that the presently operating plants are not prepared to produce efficiently the demands now being made upon such equipment. There are many who believe that by far the larger proportion of our processes are out-moded and obsolete, despite the resumption of construction activity during the past two years. A more conservative view is that about 30 to 40 percent of refining process installations are in need of modernization or replacement. A recent series of interviews with many refining concerns and with many large consulting and construction engineering organizations indicates positively that there is at this time more new work proposed and projected in this industry than at any time during the past five years.

Given a hopeful outlook or given some concrete assurance of economic stability and a fair chance at profitable operating conditions and the refining concerns of this country and many foreign countries will promptly become engaged in a very important program of process replacement, modernization and expansion. A study of activity along these lines during 1937, and of present work under way, indicates that many concerns are taking a chance either because they feel that the coming years are to be profitable ones, or because the condition of formerly used equipment was such that modernization now is absolutely necessary. Others, and there are a large number of them, continue to hold up actual work on a wide variety of projects, apparently awaiting developments both at home and abroad which will give the future a more favorable outlook. Practically all refining concerns of importance admit the need of the newer, more modern and more efficient processing methods now available.

Cracking

IN the field of cracking the combination unit has been adopted to the point where total cracking capacity of such installations is around 432,000 barrels per day. This is but approximately 20 percent of the cracking capacity of this country alone. However, the trend is well established. It is definitely in the cards that the more efficient combination unit will continue to more rapidly replace the costlier installations involving separate pipe stills for distillation and separate units for cracking.

During the period of transition to combination type of operations refiners are installing the coil-alone type of unit and the coil-and-soaking-drum systems, but usually with provisions made for additional furnaces and columns later so that conversion to combination type processing can be accomplished in minimum time and at minimum expense. At the moment several programs of cracking unit installations running well into the millions of dollars are under way in various refining centers throughout the world. In this country important major programs are underway in California, in the Texas Gulf Coast, in South Louisiana and the Great Lakes districts, most of which involve combination type cracking units, polymerization plants and solvent refining or dewaxing systems. Abroad there are important projects underway in certain South American countries, in the European refining countries, Russia and the Far East, and most of this work is comprised of combination units, coil cracking, solvent refining and dewaxing and polymerization. It would appear therefore that the continuation of activity confidently expected this year will be along the lines of combination cracking, solvent processes, and polymerization with its allied processes of hydrogenation, dehydrogenation, isomerization, and others.

Poly

THE polymerization processes, both thermal and catalytic are gaining steadily in numbers not only in this country but in certain foreign countries. Likewise, where catalytic methods are employed the process of hydrogenation is quite often involved in the general scheme of things and during the past couple of years hydrogenation as a process has come back into the picture—and much earlier than some were inclined to believe would be possible. Apparently hydrogenation is not a process of the future but is instead most certainly a process of the present.

A late analysis of the status of polymerization in the industry discloses a total of 31 units operating, under construction or under contract. Of these 5 are of the multi-coil type, 5 are of the unitary thermal process type and 21 are of the catalytic polymerization type. Doubts have been expressed that foreign countries would adopt polymerization quickly, but during the past year or so 13 poly plants have been placed abroad. These are located in Russia, Japan, Iran, Argentina, Curacao, D.W.I., Holland and Trinidad. The remaining 18 poly plants are located in the United States with

three in California, 7 in Texas, and the remaining 10 in various other refining districts. By far the larger proportion of the above mentioned installations are now completed and operating.

The polymerization processes are still fairly new to the industry, and it is only natural to assume that they have not yet reached full state of development nor have they been perfected as to design and engineering. However, there is much to indicate that the processes are to be modified and simplified to the end that installation costs will not be so great and that the cost of polymer liquids produced will be largely reduced in the near future. At the moment, however, the nature of the inquiries now in the hands of construction firms indicates that contracts for new units of this type will tend to sharply increase production of polymerized products within the next two years.

Solvents

SOLVENT refining of lubricating oils has come into wide general use during recent years. By far the larger percentage of lubricating oils are now produced by this method. However, this field is not yet saturated as is indicated by the installation work now under way and that projected. A recent recapitulation showed that 24 companies at 28 refineries had 42 of these units in this country. Since that time 2 additional installations have been announced which are now building. Abroad 15 companies at 16 plants had erected 22 units. Domestic capacity totaled 48,500 barrels and foreign capacity about 20,000 barrels or a total of 68,500 barrels. There is indicated a need for several thousand barrels additional capacity in this country and abroad which will no doubt be installed. Solvent dewaxing continues to attract attention and the propane processes for deasphalting continue in demand. Late work has indicated the adaptability of solvents under certain rather special conditions to the treatment of various types of naphthas and also to the treatment of Diesel oils for the betterment of such products. In the meanwhile the more general use of additive agents for lubricating oils is indicated. These include oiliness agents, viscosity and viscosity index improvers, pour inhibitors and oxidation and corrosion inhibitors.

Chemicals

THE trend toward the production of a wide variety of chemicals by synthesis is becoming more firmly established with each passing year. The chemical products have as their source materials the light petroleum fractions available at the refineries. Present practice in this field includes preparation of such products as ethers, glycols, alcohols, aldehydes, dyes, resins, color inhibitors, antioxidants, rubber substitutes and sulfuric acids—all of which are being synthesized from light fractions. It is within the realm of reason to conclude that the widespread production of such chemical materials might bring about a competitive condition where synthesis demands too great quantities of the light fractions which are now for the most part required by such processes as polymerization and hydrogenation in the production of high-octane motor fuel. At least, the two trends now established, namely that of chemicals synthesis and polymerization processes as we now know them are dependent upon the same source material—refinery light fractions and gasoline plant light fractions—for their future development and more general utilization.

Treating

IN the field of chemical treating the use of inhibitors has become more widespread of recent years. The accompanying economies are such that their use may well extend to the treatment of by far the larger proportion of all cracked gasoline in the next few years. Limitations of the widely-used doctor treating system have been brought to light and a number of processes threaten to make further inroads against it. Processes which tend to reduce lead requirements or to improve lead susceptibility are offered as is a modified doctor sweetening process. Numerous installations using copper salts as the sweetening agent have been installed. Likewise it has been adequately demonstrated that lead requirements may be reduced and sweetening costs reduced also by removal with caustic soda of the mercaptans. These mercaptans, or a large proportion of them can be removed by a simple caustic wash under proper conditions of contact time, temperature and alkali concentration. Further, the caustic can be revivified at very little expense. The perfection of the caustic washing system does not answer all sweetening problems however, for the gasoline must be sweetened following the removal of the hydrogen sulfide and a portion of the mercaptans.

The foregoing discussion does not touch upon a larger number of developments within and without the refining industry which bring pressure to bear upon its well being and upon its needs. Only the highlights have been touched upon and these for the purpose of pointing out the rapidity of technical and engineering development which makes possible the production of increasing yields of better products and at improved operating efficiencies. An industry traveling so fast technically, and an industry upon which all other industries rely for their proper functioning, has no time for serious contemplation of the small and ragged looking "wolf" which was described earlier. To the wolf: "Scat!" To 1938: "Let's Go!"

Heat Exchange Systems

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THE proper design and selection of heat-exchange applications in oil refining operations is often the principal function of the process engineer. In many instances the process itself must be modified and redesigned to accommodate better heat-exchange facilities.

The basic equation for heat exchange is:

$Q = A\,U\,T_m$
Q = B.t.u. per hour transferred
U = Heat transfer rate
T_m = Mean temperature difference

The problem to be considered is the selection of the proper location of heat exchange equipment so as to increase both the heat transfer rate and the mean temperature difference. The control of the rate itself, as affected by the internal design of the heat exchanger is another subject.

From the broad engineering aspect, much more can be done along the lines of proper process flow and selection of points of heat exchange than can be done by refinements of the heat exchanger itself. The latter is the problem of the technician. Future progress in design, however, will require continued thought in the latter direction to permit new applications of heat exchange.

The economics of the problem are concerned with the balance of first costs and operating utility costs. It is well to point out, however, that the use of exchangers on direct fired units primarily tends to reduce first costs. Up to a certain point, the cost per million B.t.u. for heat exchanger surface is less than the cost of a direct fired heater. Hence, the heat exchanger is used, even when fuel costs are nil.

On the distillation unit, the heat exchange is all for the purpose of reducing furnace duty, and for cooling the products. A simple system is shown in Figure 1, illustrating a single-stage atmospheric distillation unit, with heat exchange on the overhead, side streams and bottoms. Although this illustration shows heat exchange on several side streams, one or more may not be used for this purpose, depending upon the quantity and temperature of the stream in question. Buddine[1] has presented a mathematical analysis of the problem of economic selection of heat exchangers in a system of this character. However, from a practical standpoint the following comparisons are of use in choosing a stream for heat exchange:

Highest transfer rate Lowest Temperature Heat Source	Lightest liquid side streams
Highest Temperature Heat Source Lowest Transfer Rate	Residuum
Maximum Heat Source Steadiest Heat Source Low Transfer Rate High Maintenance Failure Most Serious	Overhead Vapors

It is desirable for maintenance, replacement and engineering handling, in designing a plant of this character, to develop the heat exchange at as few points as

[1] Annual Meeting of American Society of Mechanical Engineers, December 2-6, 1935.

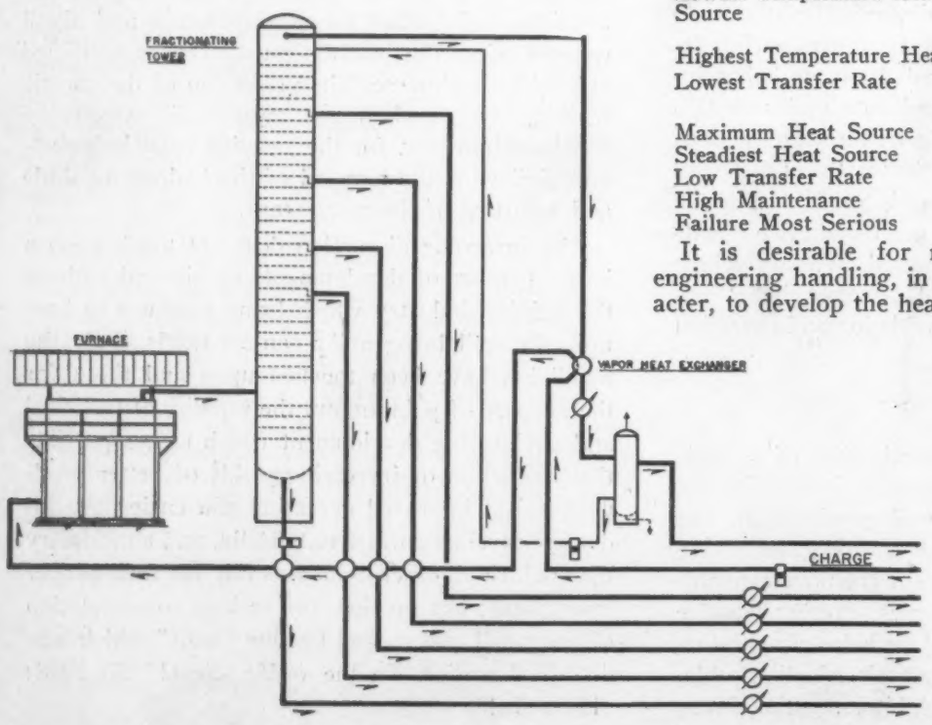

FIGURE 1
Single Stage Distillation Unit with Side Streams.

possible, using interchangeable units of reasonable size. When a crude pick-up of, say, 50°F. is possible on one stream and 10°F. on the next, it is better to neglect the stream giving the small pick-up. Only when it is expected that the unit will be operated on a wide range of charging stocks, with great changes in the quantities and temperatures of the side streams, is it desirable to provide heat exchangers on all side streams to make the economical preheat.

Reference has been made to first-cost economics and these are excellent guides to proper preheat in a system of the type of Figure 1, since the point of minimum first cost is very near to the point of minimum total cost. The following problem gives a rough guide for first cost selections:

Given: Direct fired heater cost $12.00 per sq. ft.
Average transfer rate, 6500 B.t.u. per hour per sq. ft.
Heat exchanger cost $2.00 per sq. ft.

$$\text{Cost per million B.t.u. for heater } \frac{12{,}000{,}000}{6{,}500} = \$1850.$$

Cost per million B.t.u. for exchanger 1850 maximum
Minimum transfer rate for exchanger
$2{,}000{,}000 = 1850 \times H$
$H = 1080$ B.t.u. per Hour/Sq. Ft.

Solution: Select each exchanger combination so that $U \times T_m$ = not less than 1080.

The problem is further complicated by the increased size of coolers which must be used if the amount of heat by direct firing is increased. The closer the terminal approach to the water required on the side streams, the less is this factor influential.

A simple graphical guide to enable the designer to select streams for heat exchange is shown in Figure 2. The total heats for the streams leaving the unit are plotted in reverse (i.e. total heat below maximum temperature from system). For a liquid stream the slope is—"°F. per B.t.u." or "Lbs. ÷ sp. ht." Hence, assuming no vaporization, the slope of the crude curve may be calculated. The first crude line has to begin at the inlet temperature A. The value of the abscissa B will depend on the approach C which is made to the first heat-exchange stream. Hence, by selecting C and drawing a line with the proper slope from C through A, the first problem is solved. The other streams may be chosen in turn. The quantity of heat available in a given stream, and the temperature differences can be seen at a glance by this method. In the illustration shown, it is obvious that the first side stream may be neglected.

When several operations are involved necessitating the selection of heat exchangers required to operate under a variety of conditions, the criterion "B.t.u. per Hour/MTD" should be used to determine equal loading for each exchanger. The following table shows a calculation in which this number is used to so adjust the overall heat balance as to require no excess heat exchange surface for two different operating conditions:

STREAM	Lbs. per Hour	Temperature Change	B.t.u. per Hour and M.T.D.		B.t.u. per Hour ÷M.T.D.
Operation 1					
Top reflux	472,000	230—193	9,870,000	77.3	127,800
Crude	210,000	180— 80	9,870,000		
Gas oil	38,200	480—200	6,340,000	89.3	68,900
Crude	210,000	238—180	6,340,000		
Intermediate reflux	77,000	530—310	10,800,000	124.5	99,500
Crude	210,000	331—238	10,800,000		
Residuum	116,440	650—371	20,800,000	86.5	240,000
Crude	210,000	490—331	20,800,000		
Operation 2					
Top reflux	472,000	230—193	9,870,000	77.3	127,800
Crude	210,000	180— 80	9,870,000		
Gas oil	17,100	500—185	3,240,000	70	46,200*
Crude	210,000	210—180	3,240,000		
Intermediate reflux	22,000	550—225	4,492,000	96.7	46,500*
Crude	210,000	249—209	4,492,000		
Residuum	132,240	600—300	24,400,000	93.2	262,000
Crude	210,000	446—249	24,400,000		

*A reduced rate is expected for these items, as indicated by reduced flow of hot side material.

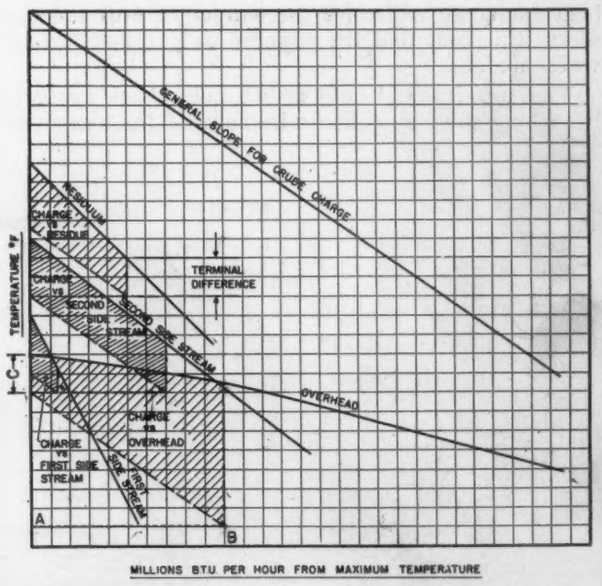

FIGURE 2

Graphical Solution of Heat Exchange Problems.

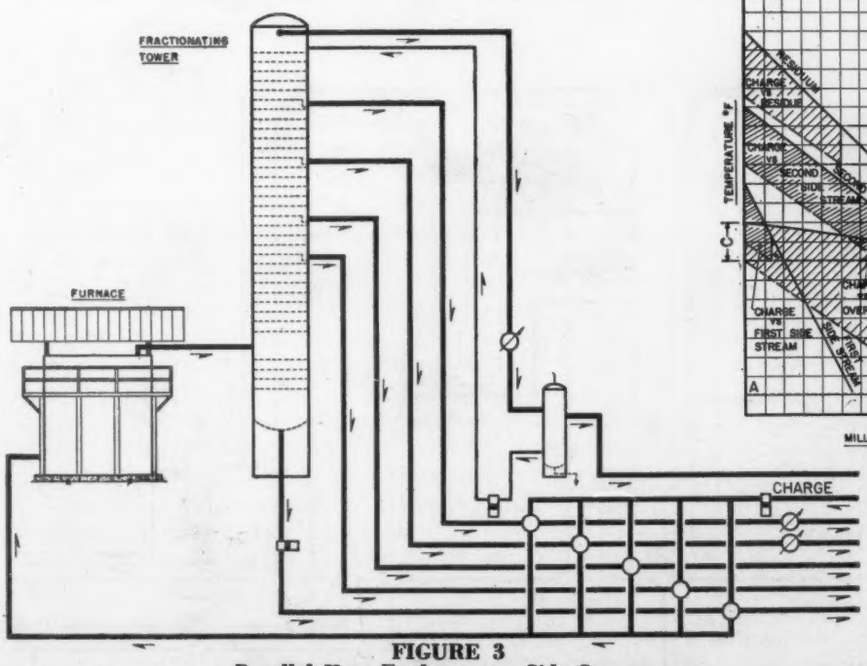

FIGURE 3

Parallel Heat Exchange on Side Streams.

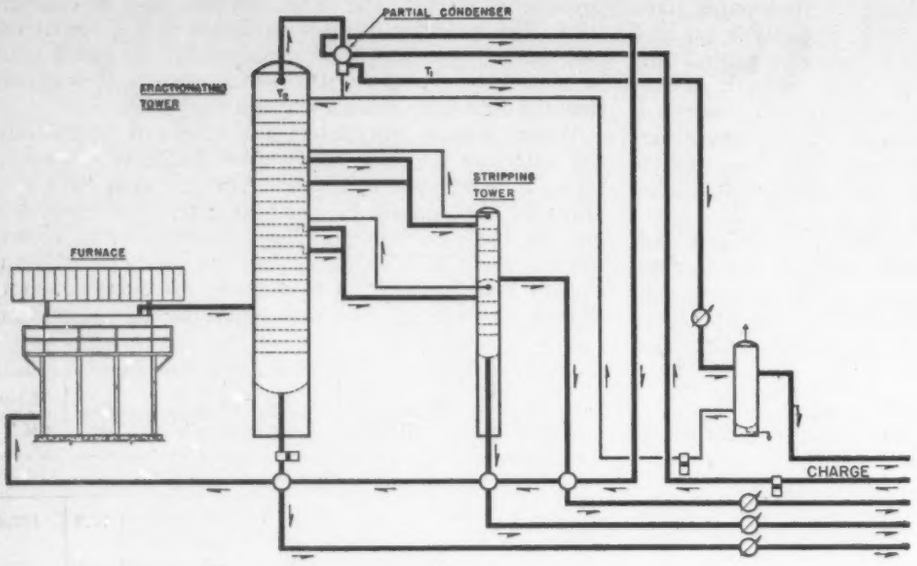

FIGURE 4

Hot Reflux Run Back System.

In Figure 1 a series flow has been shown for the crude. This is the simplest system to operate, but the heat-exchange possibilities are limited, since all of the streams cannot be cooled to their lowest temperatures by the crude. When, for reasons of maintenance and cost, it is desired to eliminate vapor-heat exchange, a high preheat may be obtained with parallel flow as illustrated in Figure 3. In this case, all of the liquid side streams may be cooled to a low temperature and the maximum heat recovery from these streams is possible. This system has not generally found favor in the United States, particularly since it is a difficult one to operate. To obtain the maximum preheat, every exchanger has to be in proper balance as to crude throughput. This requires regulation by the use of valves which is difficult to maintain in ordinary commercial operation. Vapor-heat exchange will raise the temperature of the charge to such a point that the expense of parallel flow is not warranted.

The conventional cold reflux pump-back system has been long used by refiners because of the simplicity of design and control that it offers. The use of a reflux condenser, using the pump-back (or run-back system as shown in Figure 4) has the advantage of reducing cold terminal difference for reflux condensing and increasing the top-tower temperature. For example, in Figure 4, the temperature T_1 would correspond, except for the effect of steam, to the normal top-tower temperature with cold reflux pump-back as shown in Figures 1 and 3. The temperature T_2 would be higher than T_1, since the vapors entering the reflux condenser would be considerably heavier than the final product. This system is used by some refiners on heavy vapors. It is almost universal practice in stabilizer and general gas recovery plant design because of the low vapor temperatures and the necessity of maintaining as high a mean temperature difference as possible.

The experience of the industry with gasoline vapor-crude heat exchangers has been discouraging. The units are usually of such a size that high tube stresses occur. Corrosion is high, supporting steel and piping is expensive, and heat transfer rates are low. Failure of tubes

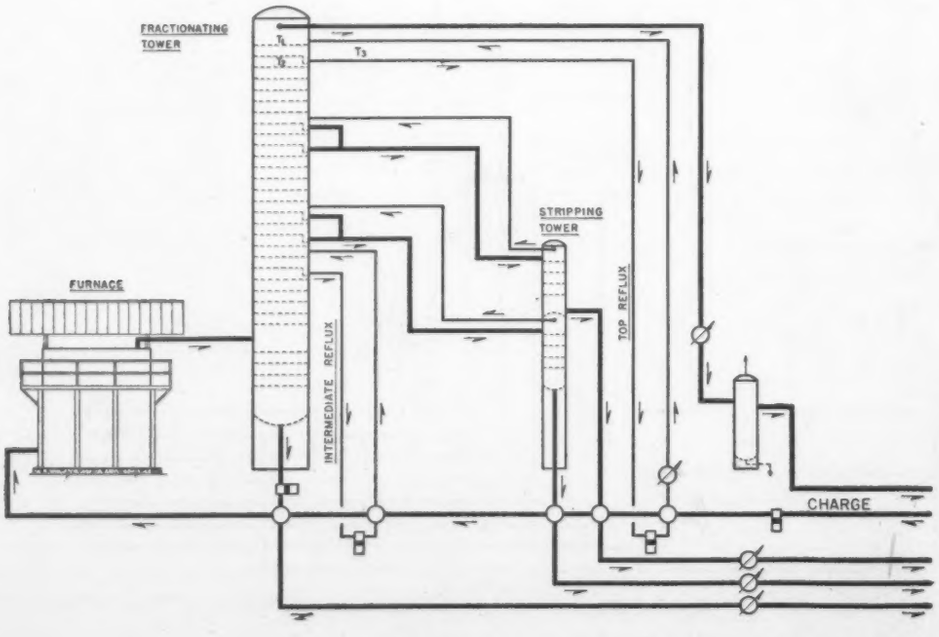

FIGURE 5

Circulating Top and Intermediate Reflux.

results in a shut down, since vapor line by-passes are expensive and are not generally used, hence the condensate, reflux, and all products become contaminated with crude. To overcome this disadvantage, circulating reflux has been gaining favor in recent installations. As illustrated by Figure 5, a stream of equilibrium condensate is drawn from the tower and pumped through exchangers and coolers, and returned to the top tray. The duty of condensing the reflux is thus handled by liquid-to-liquid exchangers placed at grade. Because of the higher pressure drop permitted in the reflux side due to pumping, the heat transfer rate may be higher than for vapor units, and inherently cheaper surface may be used. Several crude exchangers with proper by-passes may be installed preventing a shut down due to tube failure. The corrosion problem is greatly decreased, since much less overhead condensing surface need be installed. The liquid reflux is usually dry and free of the H_2S and HCl which sometimes appear in the overhead and form a corrosive solution in the condensed process steam. The temperature T_3 of the reflux drawn from the fractionating tower will approach the equilibrium vapor temperature T_2 as obtained with hot reflux, hence a higher preheat is possible with circulating reflux than with vapor heat exchangers using conventional cold pump-back reflux.

In Figure 5, circulating intermediate reflux is shown. The use of intermediate reflux is based upon the premise that with certain single flash distillation units a sufficient and reasonable number of fractionating trays can be installed to accomplish the desired separation with less reflux than naturally results from the flashing operation. If for example, in order to remove a gas oil cut from a tower, a temperature of say 650°F. were required to vaporize the crude through gas oil, it is conceivable that the high reflux thus produced in the column above the point of gas oil removal could be reduced, and that by making the column higher, sufficient fractionation of the higher side streams would still be possible. With intermediate reflux, load is taken from the top refluxing heat exchange equipment and transferred to the crude at a higher heat level, thus realizing a higher preheat than could otherwise be obtained. Regardless of the flexibility required in the rate of side stream removal, this high preheat may be obtained under various operating conditions, and no excess surface need be provided on the side streams. Intermediate refluxing reduces the diameter required for the fractionating tower, and by virtue of this and the reduced top load the overall cost of the installation may be decreased by its use. The additional tower height required, which may sometimes represent an increased first cost, is offset by the lower fuel costs. This is a typical example of the current economic trend.

Multi-stage operation has inherent fuel economies due to the lower temperatures which may be used. These reduced temperatures mean reduced reflux, and this inherent economy may be retained in a single tower design by the use of intermediate reflux. Swanson discussed this point in 1929,[2] but at that time the advantages of intermediate reflux seemed less attractive than they are today. Multi-staging is, therefore, used today for other than thermal reasons. Two cases arise wherein it becomes most desirable—the pressure flash system, and the atmosphere-vacuum system. A combined three-stage installation is shown in Figure 6.

Several recent installations for East Texas, Iraq and other crudes containing a high percentage of light ends have been designed for pressure pre-flashing in order

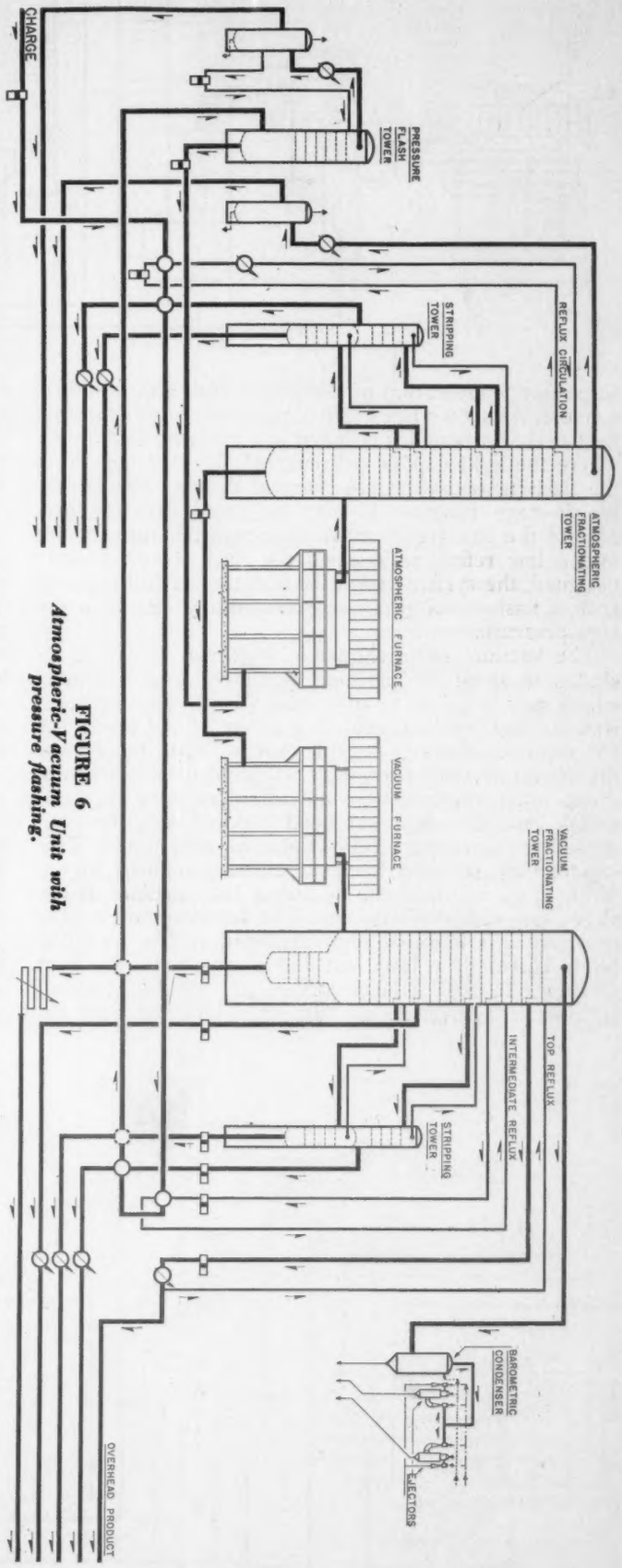

FIGURE 6
Atmospheric-Vacuum Unit with pressure flashing.

[2] H. R. Swanson transaction of A.S.M.E. Pet. 50-1; 1929.

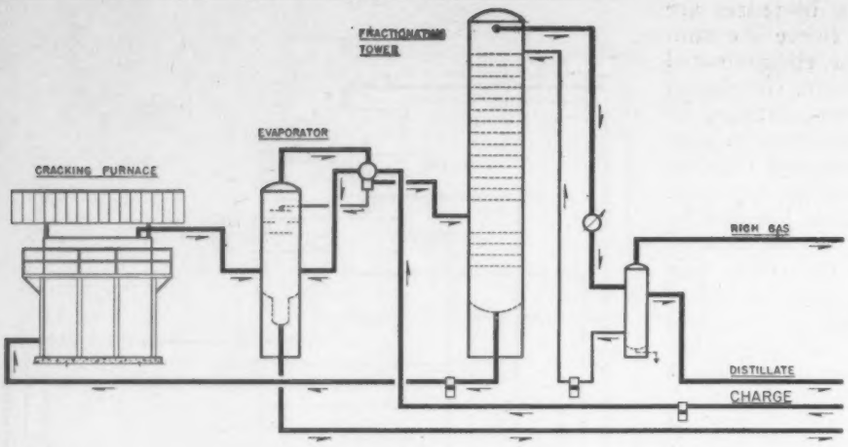

FIGURE 7

Simple single coil cracking process.

to permit condensation of these light ends and to reduce gas loss. As shown in Figure 6, the crude passes through heat exchangers and is released in a pressure flash tower where the light vapors are removed. The bottoms from the flashing operation are pumped through the atmospheric-stage furnace. It may be noted that the preheat to the furnace depends upon maintaining pressure and a low reflux ratio upon the flash tower. Closely designed, the system cannot be operated at full capacity with a flash-tower pressure substantially less than design pressure.

The vacuum stage shown in Figure 6 has been included to show the principal points of heat exchange which may be taken to advantage when designing for a wax-bearing crude. Circulating reflux at the tower top for vapor condensing only is shown. With this system the oil-vapor condenser with its problems of pressure drop, water condensation and oil carry over is eliminated, and the total overhead product may be condensed in the tower and withdrawn as a liquid. This stream may be used for heat exchange, but a higher MTD may be obtained by using intermediate reflux above the wax distillate cut. The fractionation on the overhead is seldom of high importance. The wax distillate is usually a large cut and a main point for heat exchange. Unless a large stream of cylinder stock or bottoms is recovered, no further points for heat exchange need be used. A unit designed for naphthenic crude which will not require a large atmospheric stage, or a single vacuum unit designed for lube rerun operations usually will require heat exchange on every side stream.

In the distillation unit, the essential aim of heat exchange is to increase the temperature of the feed to the plant, thereby reducing the heat input from direct fire or other sources. In the cracking unit, the temperature level of the furnace charge is usually higher than that of any heat-exchange source which may be used, and therefore heat exchange is only employed to operate auxiliary services, or to aid distillation conditions.

In Figure 7, illustrating a simple single-coil unit, the reduced crude charge must be introduced into the evaporator through a vapor-heat exchanger, or otherwise the gas oil will not be vaporized, and recycle stock from the coil will be condensed in the evaporator. The vapor-heat exchanger in Figure 7 is equivalent to the use of intermediate reflux. Recycle and feed stock are condensed and flow to the fractionator, but this heat is liberated to assist vaporization of the feed in the evaporator.

The only way in which the feed temperature to the furnace may be increased is to hold as much pressure as possible on the fractionating system. The limits of pressure are dictated by the requirement that the fur-

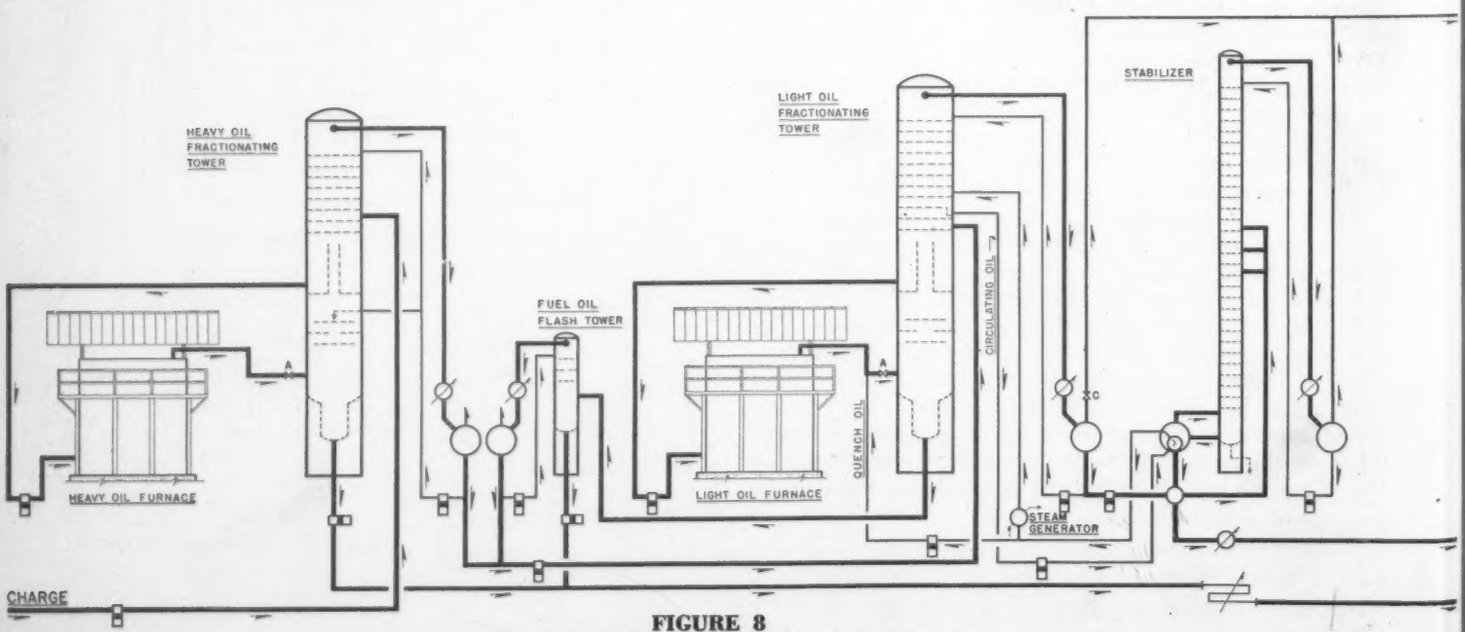

FIGURE 8

Two-Coil Reduced Crude Cracking Unit

nace outlet products must be vaporized and fractionated. A partial suppression of vaporization by high fractionator pressure requires subsequent flashing of the fuel under reduced pressure.

No practical furnace transfer line exchangers have been developed which may be used to raise the temperature of the actual furnace charge.

In Figure 8, the principle of heat exchange for partial operation of auxiliaries is illustrated. Figure 8 represents a simple series two-coil unit, in which the heavy oil, or primary coil, takes a dirty charging stock, as distinguished from Figure 7, which is a clean circulation unit. It may also be noted that a combined evaporator and fractionator is used for each stage, eliminating vapor-heat exchange possibilities.

The first fractionator is used to reduce the crude to a heavy residue, which is viscosity-broken to form a light gas oil, and a minimum of gas and gasoline, hence the first stage simply makes charging stock for the second. In the light-oil fractionator the gasoline is fractionated to end-point and the light recycle and feed stock are condensed in the reservoir section as furnace feed. The light-oil coil is operated for maximum gasoline production.

The principle of crude preheat illustrated in Figure 7 is not used, since it is not so essential to assure as high vaporization of the crude, and a portion of the recycle must be condensed as feed to the heavy-oil furnace. In this case, cold crude serves as an intermediate refluxing agent. This type of operation requires that low pressure be maintained on the heavy-oil fractionator to permit vaporization of the heavy recycle stock in the evaporator section. Conditions are unfavorable to the use of heat exchange other than direct contact in connection with the primary cracking stage.

The light-oil stage yields all of the excess heat, and all of the methods mentioned above for attaining heat economy may be used. The fractionator may be operated under pressure to increase the furnace-feed temperature, since medium boiling range materials are fractionated. This practice causes condensation of most of the butane in the gasoline distillate, which may then be charged to a stabilizer. No absorber need then be used.

The light-oil furnace operates at a high outlet temperature with a high recycle ratio, liberating a considerable quantity of heat over and above the fractionation requirements. If the fractionator and evaporator are combined, this excess heat is best removed by means of circulating intermediate reflux, which is removed from

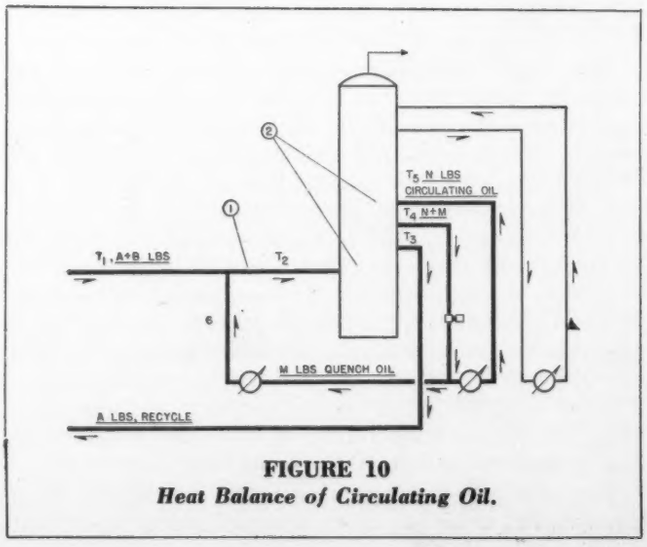

FIGURE 10
Heat Balance of Circulating Oil.

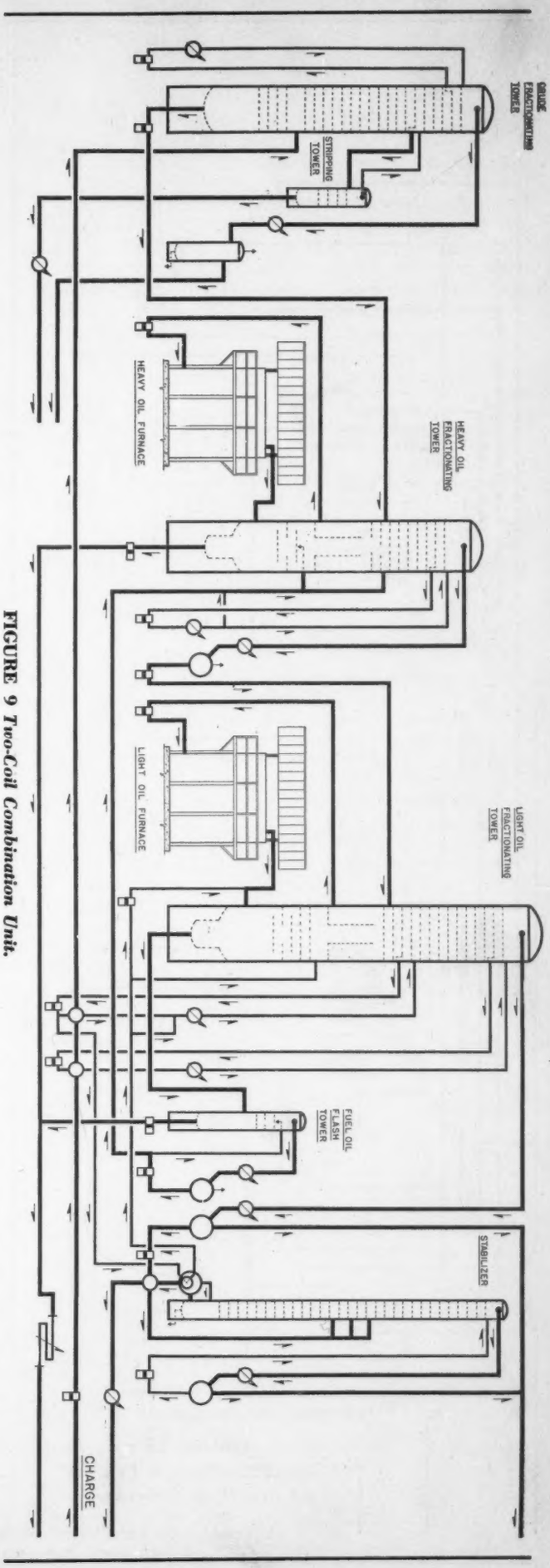

FIGURE 9 ***Two-Coil Combination Unit.***

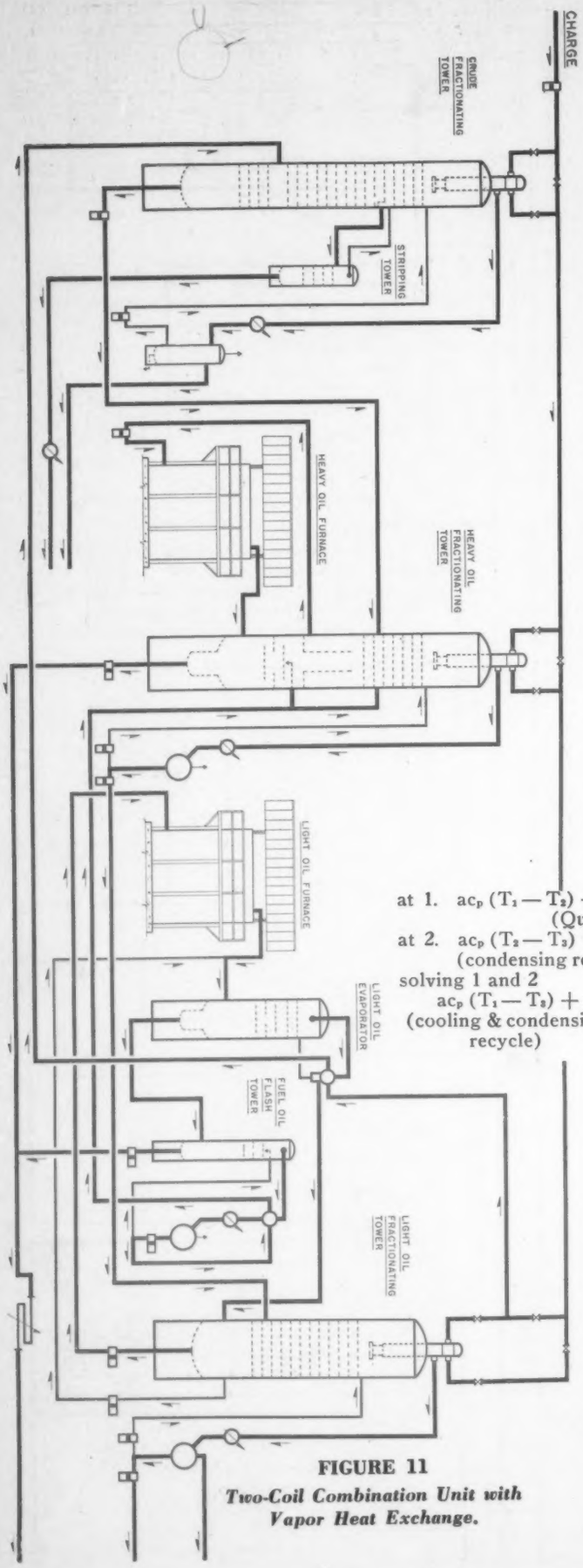

FIGURE 11

Two-Coil Combination Unit with Vapor Heat Exchange.

the light-oil fractionator and pumped through the stabilizer reboiler. A portion is used for quenching, while the balance is returned to the fractionator. A steam generator may often be used in this circuit in place of a cooler. In this way the heat which is supplied to the system in the form of fuel may be recovered in the form of steam.

The greatest use for auxiliary heat exchange is found when a cracking unit is to be designed to run crude, instead of reduced crude. Since the straight run light distillates such as gasoline and kerosene are not allowed to be mixed with the cracked distillates, separate fractionation of these products is required. A two coil system with separate crude flashing facilities, usually operated by heat exchange, constitutes a combination topping and cracking unit. Such a unit is illustrated by Figure 8. In this design intermediate reflux and top circulating reflux are used to preheat the crude and operate the stabilizer. With the light oil tower under pressure, the excess heat from a unit of this type is barely sufficient to operate these auxiliaries, hence the maximum heat economy is obtained. The amount of heat available as intermediate reflux depends primarily upon the recycle ratio, which is determinable apart from heat exchange considerations. A low recycle means a low first cost and operating cost, and a small amount of recoverable heat. Recycle stock may be partly condensed by intermediate reflux, but a sufficient reflux ratio must be preserved at the tower top to permit the production of end point specification gasoline. Once the recycle ratio and the top reflux ratio have been set, the heat to be removed by intermediate reflux may be determined.

The heat which may be transferred by high level heat exchange will depend upon the return temperature of the quench oil and intermediate reflux.

Referring to Figure 10, a simple system is shown in which the quench oil, circulation oil and recycle stock all have different minimum temperatures. Call latent heat L, and specific heat c_p, then:

at 1. $ac_p(T_1 - T_2) + bc_p(T_1 - T_3) = mc_p(T_2 - T_6) + mL$
(Quenching) (Quenched)

at 2. $ac_p(T_2 - T_3) + aL + b(T_3 - T_4) + mc_p(T_2 - T_4) + mL = nc_p(T_4 - T_5)$
(condensing recycle) (intermediate reflux) (quenched) (Circulating oil)

solving 1 and 2

$ac_p(T_1 - T_3) + aL + bc_p(T_1 - T_4) = mc_p(T_4 - T_6) + nc_p(T_4 - T_5)$
(cooling & condensing recycle) (cooling products intermediate reflux) (quenched) (circulating oil)

From this relationship the total amount of circulating oil can be rapidly estimated without making a tedious internal balance. Note that quantity $m + n$ does not depend upon T_2, but does depend upon $T_6 + T_4$.

For a rigorous determination of proper circulating oil return temperature, an economic balance of pumping equipment and costs versus heat exchange initial costs must be determined. If the oil is cooled so low that all of the heat cannot be imparted to auxiliary units, the cost of extra means of heating them must be figured. Whenever water cooling is required upon a circulating oil stream, the maximum heat is not being delivered to the crude, the stabilizer, etc. In some designs it becomes of great advantage to utilize all possible heat for such auxiliary service as pressure distillate rerunning. In this case the quench oil may be used without water cooling, and the required circulating oil quantity is increased to bring the return temperature to the fractionator sufficiently high to permit 100 percent heat exchange.

The principle of circulating reflux has so far been stressed, but units are often designed using vapor heat

exchange throughout. The same process as shown in Figure 8 is shown in Figure 11, but with vapor heat exchange.

The crude is heated by series flow through vapor-heat exchangers acting as partial reflux condensers. This is comparable with the use of circulating top reflux in Figure 9. A vapor-heat exchanger between the light-oil evaporator and the light-oil fractionator takes the place of intermediate reflux with circulating oil. The relative economics of the two systems are not fully established, since maintenance and fixed charges on vapor-heat exchangers have not been sufficiently well evaluated. The fact that both types of plants are being built, and that each has its strong advocates, is illustrative of the pioneering nature of oil refinery engineering today in spite of 10 years of phenomenal progress.

The advantage in heat economy inherent in the high-pressure fractionating system is due to increased furnace-feed temperature. For vapor-phase cracking, a low-pressure fractionation system is required, resulting in a low temperature furnace charge. Combined with the high coil-outlet temperatures used (1050°F.-1150° F.), a substantially higher fuel consumption is obtained than for a high-pressure unit. Every effort is therefore made to employ heat exchange to run auxiliaries and to generate steam to the fullest extent, in order to offset the greater fuel consumption by full utilization of the heat.

The absorber, which the gas-recovery system of a low-pressure cracking unit always requires, tends to defeat the designer's purpose somewhat, due to the necessity of stripping the rich oil.

In the process shown in Figure 12, the rich oil is returned to the light-oil fractionator, thus dispensing with a still. This removes heat from the tower, and diminishes the excess heat available to operate auxiliary units. In this case a lean oil to rich oil exchanger, as shown at D may be used to exchange low temperature level heat. As a consequence, less recycle stock is condensed by the rich oil and more vapor is available to be condensed by the circulating oil. This is another example of heat exchange used to aid distillation conditions, but with the further purpose of increasing the heat input to auxiliaries. A high oil circulation rate on the absorber will demand greater heat exchange at D, consequently the application of a gas compressor at B becomes economical for the high recovery of light hydrocarbons.

Reforming is conducted either once through or at a negligible recycle ratio, hence reforming units are deficient in the heat which is available for auxiliary services. In the case of a reforming coil used on a combination unit, the reforming coil outlet terminates in the light oil fractionator. This imposes a greater fractionating duty upon the column, requiring a higher reflux ratio at the top, and reducing the permissible internal reflux. Consequently, less heat exchange may be obtained on a unit with a reforming coil than one making an equivalent quantity of gasoline from reduced crude or gas oil alone. This is particularly true if the reforming coil is quenched with gasoline, a practice often found necessary to avoid coke formation. The heat recovery possible from a separate reforming unit is usually barely sufficient to operate the stabilizer. The charge must be preheated to the fullest extent by low level heat sources to release circulating oil for heat exchange purposes.

The complexity of heat transfer economics and design technique as applied to cracking and distillation units is great. The endless variety of heat exchange applications and heat balance systems in use are, in part, evidence that the pioneering stage is still with us. Nevertheless, the variety of crudes, special local problems, and special emphasis on first cost or operating cost which confronts the designer today will continue to face him as long as oil is refined. Few designs can be standardized, and as a consequence, one of the fundamental services of the designing engineer will always be the selection of the most correct heat-exchange system possible for the problem at hand.

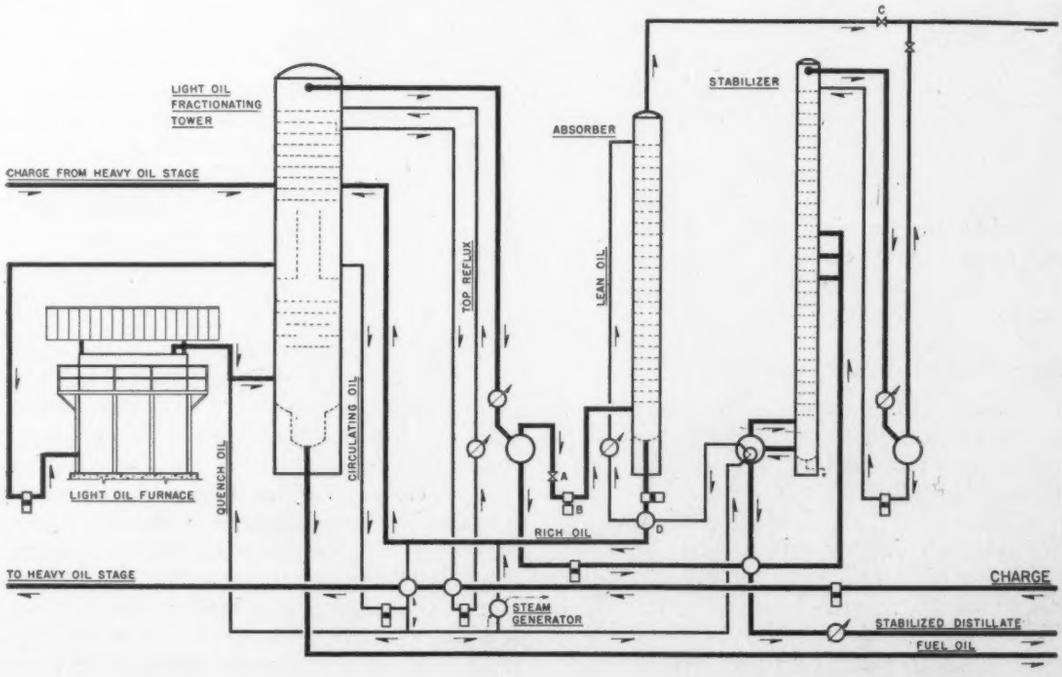

FIGURE 12
Gas Recovery System for Low Pressure Cracking Unit.

The Improvement of Diesel Fuels *By Extraction With* Sulfur Dioxide

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and
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"A DIESEL engine does about twice as much work on a pound of fuel as a spark-ignition engine." This recent statement of Charles F. Kettering gives the secret to the continued and rapid development of the Diesel engine. Used first as stationary engine for the supply of industrial power only, it has entered the field of transportation and drives tractors, ships and high speed trains. Being definitely established there, the Diesel engine is now competing with the spark-ignition engine used for road transportation in trucks and buses. The heavy-duty truck equipped with a smoke stack and carrying its load under a black flag and with a sharp acrid odor, has become a familiar vehicle of the highway, especially in the western part of the United States. In this development towards the high-speed Diesel engine, Diesel smoking and Diesel smelling are faced as the major problems and efforts to overcome them are made by engine manufacturers and oil refiners.

Fuels of predominantly paraffinic nature are experienced to give the best results in the high-speed Diesel engine, while fuels rich in aromatic hydrocarbons are the least desirable.[1] In the field of illuminating oils, a similar situation existed years ago, calling for the removal of the smoke-forming aromatics to improve the burning qualities of kerosines. This separation was successfully achieved by extraction with liquid sulfur dioxide, a method invented and developed by L. Edeleanu and now generally used for the refining of kerosines. In view of the efforts to provide more satisfactory fuels for high-speed Diesel engines, it appears of interest to study the use of Edeleanu refining for the improvement of Diesel fuels.

SPECIFICATIONS OF DIESEL FUEL

Diesel fuels are mainly prepared from petroleum and comprise straight-run or cracked gas oils. Parts of the kerosine cut and of the fuel oil may be included. Due to its origin, these products vary in chemical composition and physical properties and the necessity of establishing specifications has been realized to assure high efficiency of present Diesel engines and to widen the road for further development in this field.

The recommended specification tests[2] refer first to those characteristics which effect the proper feeding of the fuel to the injection valve and comprise limitations on the ash content, the percentage of water and sediments, and on the pour point. Proper fuel distribution in the combustion chamber is controlled by the type of fraction used, and is assured by adopted specifications of the distillation characteristics, the viscosity and the flash point. In order to provide highest efficiency as obtained by combustion without the formation of smoke, deposits, objectionable odor or corrosive substances, tests are in use specifying the ignition quality, the carbon residue formation and the sulfur content of the fuel. Edeleanu refining improves the combustion qualities of the fuel, and the reasons for these tests will be considered briefly.

The fuel leaving the injection valve of a Diesel engine enters the cylinder. Ignition starts after a delay period required to bring the fuel to its ignition point. The length of the delay period determines the rise of pressure during the combustion and it also determines the smoothness of the pressure increase during the combustion cycle; the control of the delay period is, therefore, essential. Experience teaches that the paraffins require the shortest time to ignite, the aromatics the longest and that out of a hydrocarbon group those members with the greatest number of carbon atoms ignite most readily.[3] The ignition quality of a Diesel fuel can be expressed by its cetane number, a value found by an engine test and based on the comparison of the fuel with the behaviour of a mixture of cetane and alphamethylnaphthalene. This method of testing is still somewhat in its experimental stage and the ignition qualities of a Diesel fuel are at present specified in terms of Diesel index numbers or aniline points, methods which refer to the chemical composition of the fuel. Experiments show that an almost straight line relationship exists between the cetane number and the aniline point of Diesel fuels derived from petroleum.[4] The Diesel index number is calculated from the aniline point and the A.P.I. gravity, and is considered one of the most important characteristics of Diesel fuels.

The carbon residue test gives information on the carbon-forming property of the oil. A dirty exhaust, sticking of piston rings and the formation of carbon, especially around the nozzles, are experienced with fuels containing a considerable portion of heavy residues. After-burning is then usually observed, followed by the formation of aldehydes and acids which, along with the sulfur dioxide formed from fuels with high sulfur contents, are the cause of rapid corrosion.

THE SULFUR DIOXIDE EXTRACTION OF DIESEL FUELS

In the experiments, showing the effect of Edeleanu refining Diesel fuels, the improvement of the ignition qualities as indicated by the Diesel index number is primarily considered. Four straight-run products, two of the paraffinic and two of the non-paraffinic type, are used, and two oils produced by cracking operations are included. All extractions are made at a temperature of 30° F. and consist of multiple-batch treatments, using various quantities of sulfur dioxide. The volumes of sulfur dioxide are converted by known factors into those required in continuous operation.

PARAFFINIC GAS OILS

Fuel No. 1 is a Pennsylvania gas oil having a Diesel index number of 68 and an aniline point of 185° F. The fuel distills between 480 and 680° F. Pennsylvania stocks are best known for the extremely high percentage of paraffinic constituents which they contain and are believed to represent the best Diesel fuel, now available on the market. The extraction of the Pennsylvania gas oil with 300 percent of SO_2 produces 84 percent of a fuel with a Diesel index number of 79 and an aniline point of 202° F.

Fuel No. 2 has a Diesel index number of 58, and an aniline point of 175° F.; it distills between 400 and 600° F. Refining the same with 300 percent SO_2 results in the production of 64 percent of fuel with a Diesel index number of 85 and an aniline point of 209° F., while extraction with 100 percent of SO_2 yields 79 percent of fuel with a Diesel index number of 77, and an aniline point of 197° F. Diesel fuels with Diesel index numbers of around 80 and aniline points of above 200° F. can thus be produced by the Edeleanu refining of straight-run paraffinic gas oils.

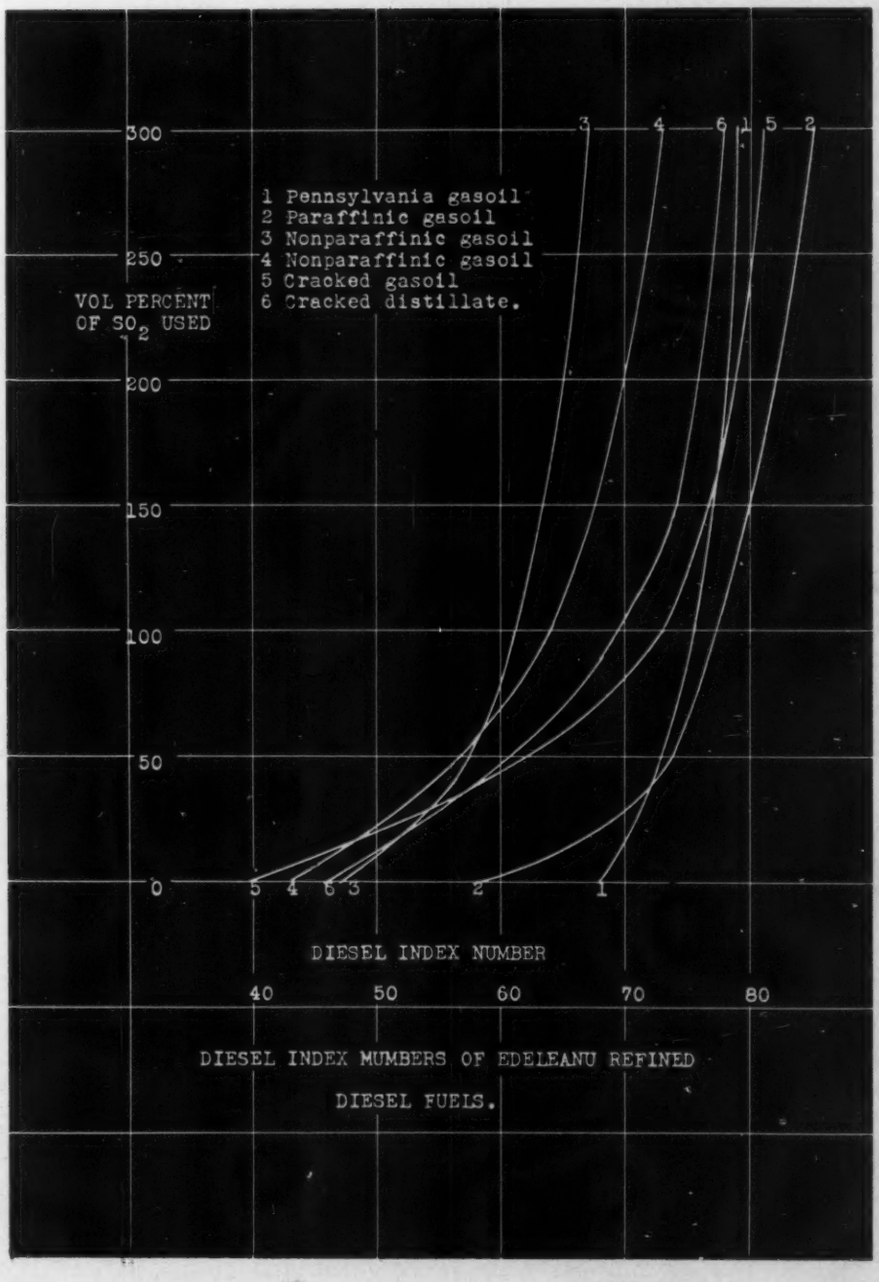
NONPARAFFINIC GAS OILS

The fuels No. 3 and 4 are of the nonparaffinic type. They have Diesel index numbers of 47 and 43 and aniline point of 156 and 150° F., respectively. Stock 3 distills between 400 and 600° F., and stock 4 distills between 560 and 670°F. The extraction of fuel 3 with 100 percent of SO_2 produces 77 percent of fuel with a Diesel index number of 61 and an aniline point of 170° F. Raising the quantity of SO_2 to 300 percent, gives 55 percent of raffinate with a Diesel index number of 67 and an aniline point of 180°F.

Fuel No. 4, treated with the same quantity of SO_2 yields 69 percent of a 64 Diesel index number product having an aniline point of 185° F., and 57 percent of a 73 Diesel index number product with an aniline point of 195°F., respectively. The results indicate that non-paraffinic gas oils can be refined by sulfur dioxide extraction producing Diesel fuels which, as tested by the Diesel index number and the aniline point, are superior to those obtained by distillation of paraffinic crudes, such as a Pennsylvania crude.

CRACKED GAS OILS

Especially good results are obtained with cracked gas oils, represented by the fuels Nos. 5 and 6. Fuel No. 5 having a boiling range of between 400 and 600°F., is found to have a Diesel index number of 40 and an aniline point of 125°F. On extraction with 100 percent of SO_2 it gives 56 percent of raffinate with a Diesel index number of 73 and an aniline point of 173°F. Increasing the quantity of SO_2 to 300 percent produces 49 percent of refined



fuel with a Diesel index number of 81 and an aniline point of 183°F.

Oil No. 6, obtained as a side cut of a Tube and Tank cracking unit, distills between 380 and 520°F. point of 124°F. Extraction with 100 percent of sulfur It has a Diesel index number of 46 and an aniline dioxide gives 61 percent of raffinate with a Diesel index number of 72 and an aniline point of 163°F. A fuel with a Diesel index number of 78 and an aniline point of 172°F. is prepared at a yield of 48 percent by extraction with 300 percent of sulfur dioxide.

A study of the results, illustrated by experiments with the fuels Nos. 5 and 6, reveals that cracked gas oils are suitable stocks for the production of Diesel fuels with good ignition qualities by Edeleanu extraction. The Diesel index numbers of these products are superior to those obtainable from non-paraffinic gas oils by similar treatment. The aromatic stocks resulting as by-products in these operations appear to be good charging stocks for cracking units and are assumed to give gasolines with better anti-knock properties than those obtainable from gas oils recycled without sulfur dioxide extraction.

TABLE 1

Effect of Sulfur dioxide extraction on the Ignition Qualities of Diesel Fuels.

	Volume Percent of Sulfur Dioxide Used					
FUEL No.	0	50	100	150	200	300
Straight-run Paraffinic Gas Oils:						
[1] Raffinate, % by Wt.	100	92	90	87	85	84
Extract, % by Wt.	0	8	10	13	15	16
Diesel Index Number	68	73	75	77	78	79
Aniline Point, ° F.	185	...	196	...	...	202
[2] Raffinate, % by Wt.	100	82	79	76	69	64
Extract, % by Wt.	0	18	21	24	31	36
Diesel Index Number	58	74	77	80	82	85
Aniline Point, ° F.	175	...	197	...	...	209
Straight-run Nonparaffinic Gas Oils:						
[3] Raffinate, % by Wt.	100	82	77	73	69	55
Extract, % by Wt.	0	18	23	27	31	45
Diesel Index Number	47	58	61	63	65	67
Aniline Point, ° F.	156	...	170	...	...	180
[4] Raffinate, % by Wt.	100	79	69	65	61	57
Extract, % by Wt.	0	21	31	35	39	43
Diesel Index Number	43	57	64	68	70	73
Aniline Point, ° F.	150	...	185	...	...	195
Cracked Gas Oils:						
[5] Raffinate, % by Wt.	100	65	56	54	52	49
Extract, % by Wt.	0	35	44	46	48	51
Diesel Index Number	40	62	73	76	79	81
Aniline Point, ° F.	125	...	173	...	...	183
[6] Raffinate, % by Wt.	100	73	61	59	56	48
Extract, % by Wt.	0	27	39	41	44	52
Diesel Index Number	46	61	72	74	76	78
Aniline Point, ° F.	124	...	163	...	...	172

Table 1 gives more detailed information on the ignition qualities and yields of Diesel fuels obtained from the various charging stocks with increased percentages of sulfur dioxide. The results are also presented in the form of graphic figures.

RECOMMENDED FUEL SPECIFICATIONS

At present the United States Navy recommends fuel specifications for high-speed Diesel engines as shown in Table 2. For comparison, tests are included on two Diesel fuels produced by the Edeleanu refining of a paraffinic and of a cracked gas oil. For submarine services a stock with a Diesel index number of 45 is required, its maximum sulfur content being 1.0 percent, and its maximum carbon residue 0.2 percent. A product with a Diesel index number of 60, a maximum sulfur content of 0.75 percent, and a maximum carbon residue of 0.1 percent is recommended for aircraft purposes.

Out of the six original fuels investigated and reported in Table 1, only the Pennsylvania gas oil meets the specifications set for aircraft fuels. One of the cracked stocks having a Diesel index number of 40 does not even meet the specifications adopted for use in submarines.

These experiments prove that fuels with Diesel index numbers of 60 are obtainable from all stocks by extraction with less than 100 percent of sulfur dioxide. The paraffinic and the cracked gas oils, refined with 100 percent of sulfur dioxide, yield raffinates with Diesel index numbers of between 72 and 77. More severe SO_2 treatments produce fuels with Diesel index numbers of around 80.

It is the general experience in SO_2 extractions that the sulfur containing and the carbon-residue-forming substances are removed along with the aromatic hydrocarbons. Table 2 shows that the Edeleanu-refined Diesel fuels have extremely low sulfur contents and extremely low carbon residues. The low flash and viscosity characteristics experienced with the fuel produced from the cracked stock are attributed to the low boiling range of the cut used and will not be found for stocks having a distillation range of between 400 and 600°F.

The pour points of the stocks reported are high. It is known that pour-point depressors will overcome this. Since these fuels will not be subjected to high temperatures before use, these pour depressors do not have to be of the heat resisting type, as required for crank-case oils and low-priced pour point inhibitors will be sufficient for this purpose.

TABLE 2

Tests of Edeleanu Refined Diesel Fuels

	U. S. Navy Specifications For		Edeleanu Refined Diesel Fuels From	
	Submarine Service	Aircraft Service	Cracked Gas Oil by 75% SO_2	Paraffinic Gas Oil by 150% SO_2
Viscosity S.U. at 100° F.	35–45	35–45	32.3	44.4
Sulfur, %	1.0 Max.	0.75 Max.	0.01	0.04
Carbon Residue, %	0.2 Max.	0.1 Max.	0.03	0.02
Ash, %	0.01 Max.	0.01 Max.	0.003	None
Flash Point, ° F.	150 Min.	150 Min.	136	154
Pour Point, ° F.	0 Max.	—40 Max.	+ 40	— 25
Distillation Characteristics:				
10% at ° F.	.....	400 Min.	410	450
90% at ° F.	675 Max.	600 Max.	490	650
Diesel Index No.	45	60	67	80

CONCLUSION

In conclusion, it should be noted that Diesel smoking and Diesel smelling now experienced in high-speed Diesel engines will be greatly reduced and probably be overcome entirely by the use of Edeleanu-refined Diesel fuels. The selective solvent property of sulfur dioxide removes the less desirable aromatic hydrocarbons and produces fuels with Diesel index numbers of between 60 and 80, which have extremely low sulfur contents and improved carbon residues. Cracked gas oils are especially susceptible to such treatment. These Edeleanu-refined Diesel fuels, as shown by specification tests, are superior in quality to any natural petroleum product. The quantities of sulfur dioxide required are small and correspond to those used in the Edeleanu refining of kerosines. Extraction temperatures of 30°F. are used, whereby such method of refining becomes even less expensive than the sulfur dioxide extraction of kerosines.

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Status of Polymerization

in Connection With

Natural Gasoline Manufacture

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DURING the past two years several papers have been published bearing on the practical operation of polymerization processes; however, much of this material has been prepared for the purpose of advocating one or another of the commercial processes now available. Much of it is also confused, from the standpoint of the natural gasoline manufacturer, by being based on "combination" operations, in which light products from oil cracking make up part or all of the feed to the polymerization unit.

The purpose of this paper is to present, in an entirely general and disinterested way, information regarding the present state of the polymerization art as applied to the conversion of the light materials which can be derived from stabilizer discard in the ordinary natural gasoline plant. From the standpoint of the natural gasoline plant owner, I will attempt to answer the following questions:

1. What is the general purpose of polymerization?
2. What commercially successful processes are now available?
3. How do they operate?
4. How much and what do they produce?
5. What is the plant investment cost.
6. What is the operating cost?
7. Under what conditions will a polymerization plant pay?

General Purpose of Polymerization

The general purpose of polymerization is to at least partially conserve for use as motor fuel the materials in the stabilizer discard, which in many natural gasoline plants are either wasted or else used for low-grade fuel purposes. By the polymerization operation the butanes, and to some extent propane, are partially converted into liquids having a normal gasoline boiling-range, and which consequently can be economically stored and handled with normal facilities.

In addition to conserving materials which might otherwise be wasted, it has been found that polymerization produces fuels having uniquely valuable properties, which will be discussed in the answer to question 4.

COMMERCIAL PROCESSES AVAILABLE

Two general types of plants are in commercial use: the straight heat-pressure-time type plants and plants in which a catalyst is used to assist in the conversion.

The "Unitary Thermal Polymerization Process" is representative of the first type; this process is owned and licensed by The Polymerization Process Corporation through its licensing agent, The M. W. Kellogg Company. This process was developed jointly by Phillips Petroleum Company, Standard Oil Company (Indiana), Standard Oil Development Company, The Texas Company, and The M. W. Kellogg Company. The first commercial plant using this process is at the Alamo refinery of Phillips Petroleum Company at Borger, Texas. This plant began successful operation around 1933, and has been increased in capacity several times since then. Operations of this plant are discussed in an article by J. S. Carey in the December, 1936, issue of REFINER & NATURAL GASOLINE MANUFACTURER.

It is obvious that many modifications of this type of operation are possible, depending both upon the nature of the raw feed and upon the nature of the final products desired. One such modification is described in an article by Ridgway, Wagner and Swanson in the November 4, 1936, issue of "National Petroleum News."

The Dubbs Catalytic Process, is, so far, the only commercial application of a catalytic process. This process is owned and licensed by Universal Oil Products Company. The first commercial plant using this process for converting straight natural gasoline plant stabilizer discard was placed in operation in March this year at the McKee gasoline plant of the Shamrock Oil and Gas Corporation in the north Texas Panhandle.

SCHEMES OF OPERATION

In order to make a heavy, gasoline-range hydrocarbon out of the light raw materials, propane and butane, it is obviously necessary to induce two or more molecules of the light materials to join together, forming a new molecule containing more than three or four carbon atoms, and consequently having a higher boiling point than the original propane or butane. Unfortunately, the propane and butanes extracted from natural gas belong to the "saturated" or paraffin series of hydrocarbons, and are very inert chemically. On this account, no direct method has yet been discovered for making the light paraffins combine together to form heavier ones.

However, it has been found that by subjecting the light paraffins to heat and pressure for a suitable length of time, they are broken down into other types of hydrocarbons which are "unsaturated," or contain more carbon relative to hydrogen than do the paraf-

*Presented before the annual meeting of the California Natural Gasoline Association, November 16, 1937, Los Angeles, California.

fins, and which are relatively active chemically. The light unsaturated compounds so produced can then be made to combine with each other to form heavier compounds, either by a suitable continuation of the heat-and-pressure treatment, or by the use of a catalyst.

Endless numbers and kinds of products may be produced by the initial breaking-down step, depending upon the degree of the heat and pressure applied and the time duration of the treatment. Likewise the nature of the products of the final recombination may be widely varied by the same factors.

Without going into the almost infinite mass of possible reactions which can and do take place Figure 1 is presented to show one set to illustrate the general idea.

FIGURE 1

Breaking Down Step

Feed—Propane C_3H_8 (Saturated) + H, P, T = Ethylene C_2H_4 (Unsaturated) + Methane CH_4

Feed—Butane C_4H_{10} (Saturated) ± H, P, T = Propylene C_3H_6 (Unsaturated) + Methane CH_4

Polymerizing Step

Ethylene C_2H_4 + Propylene C_3H_6 ..... = Pentenes C_5H_{10}
Approx. Boiling Pt. 92° F. — Sp. Gr. 0.65.

or

Propylene C_3H_6 + Propylene C_3H_6 ..... = Hexenes C_6H_{12}.
Approx. Boiling Pt. 130° F. — Sp. Gr. 0.72.

This is not intended to represent even a small part of the reactions which actually do take place; some idea of the tremendous complication of these may be gained from the fact that an analysis of the total final products of an operation will show everything from hydrogen gas to extremely heavy tars.

Both the straight thermal process and the catalytic process, then, use the initial heat-pressure-time step for converting the paraffin feed stock more or less completely into unsaturates. In the simple thermal process the conversion of the light unsaturates into heavy ones is accomplished along with the initial breakdown in one operation; in the catalytic process the conversion is partly accomplished by treating the fractionated products of the break-down with a catalyst. In both processes the final step consists of fractionating out the undesired products, to yield a final liquid product of the desired boiling range. Both processes also require some recycling of materials in the thermal stage, since the reactions do not carry through to completion in a once-through process. The recycle material is derived from the fractionation following the primary conversion, and is made up of the unconverted paraffins and some of the unsaturates which are too light to retain in the final product.

Figure 2 shows a flow-sheet for the Unitary Thermal Process. The feed, consisting of stabilizer discard in liquid form, enters through line (1), and together with the recycle stock, flows to storage tank (2). Pump (3) delivers the liquid through feed exchanger (4), through the reaction coil (5) in the tube furnace, and into the fractionator (6).

In this fractionator all materials which are too light for use in the final product, including the unconverted propane and butane, are taken overhead and delivered to the "gas recovery system," (7),

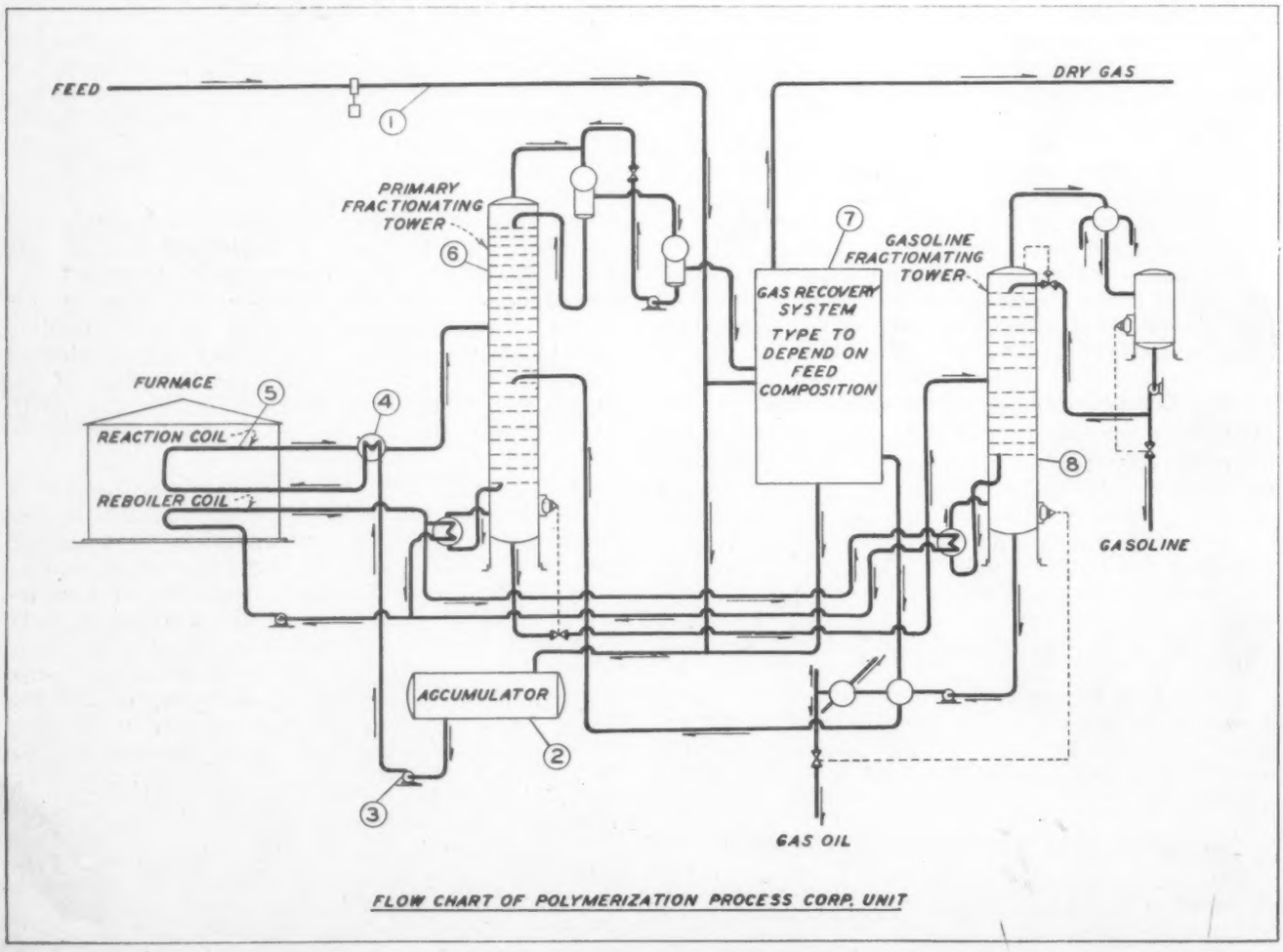
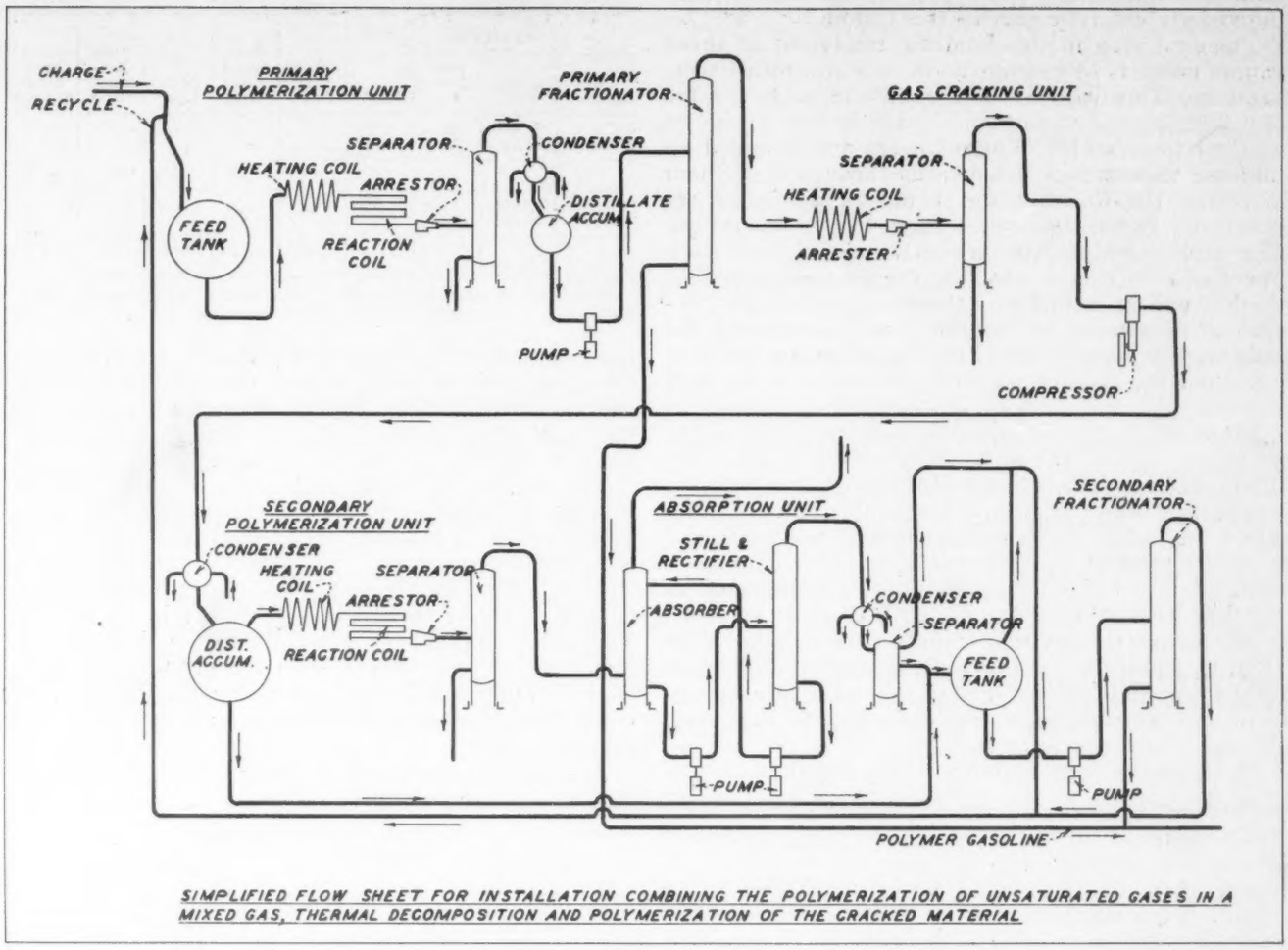


FIGURE 2



SIMPLIFIED FLOW SHEET FOR INSTALLATION COMBINING THE POLYMERIZATION OF UNSATURATED GASES IN A MIXED GAS, THERMAL DECOMPOSITION AND POLYMERIZATION OF THE CRACKED MATERIAL

FIGURE 3

which can be of any suitable type, such as an absorption or compression unit.

The recovery system separates and discards to fuel all material lighter than ethylene, and makes two liquid products: one consisting of unconverted propane and butane and the corresponding C_3 and C_4 unsaturates, and the other consisting of the heavier unsaturates which can be used in the final product. The first of these joins the incoming raw feed for recycling. The heavier product is fed to the primary fractionator below the feed tray, where it largely mingles with the bottom product from the column.

The bottoms from the primary fractionator are fed to the gasoline fractionator (8), where the materials within gasoline boiling range are taken overhead and condensed to make the final product. The heavy materials are withdrawn from the bottom of this column, for use as gas/oil or fuel oil.

Figure 3 shows one of the many possible modifications of the above system; in this case designed for making special products. Here the feed is put through a primary polymerizing step, and the gases produced in this step are cracked, put through a second polymerization unit, and the products are finally fractionated and partially recycled through an absorption recovery system.

Figure 4 shows the flow sheet of the Dubbs process plant of Shamrock Oil & Gas Corporation.

The raw feed of fractionated butane first enters the storage tank (1) and is pumped by the feed pump (2) through the butane cracking furnace (3). Operating temperatures through the tubes of this furnace range from 1000° to 1150°F., with pressures ranging from 800 to 1000 pounds. The primary breaking down and partial re-combination steps occur in this furnace, the time element being provided by a large group of tubes on the outlet side of the furnace.

From the cracking furnace the material passes in vapor form through reboiler exchanger (4) to the vapor cooler (5), and thence to the debutanizer column (6).

In the debutanizer column the primary separation is made between the heavy polymerized material formed in the cracking furnace and the light materials which require further polymerization in order to get them down within gasoline boiling range. The reboiler heat required for the operation of this column is secured by re-circulating liquid from the bottom of this column through a part of exchanger (4) and back into the bottom of the column, by means of reboiler pump (7). The top temperature of the debutanizer column is controlled through a conventional reflux circuit, so as to take overhead only those materials which are too light to retain in the finished gasoline. This light material leaves the col-

umn through transfer line (8), which carries it to the strictly catalytic part of the system.

The first step in the catalytic treatment of these vapors consists of heating them to a controlled temperature. This is done in the butane vapor heater (9). The heated vapors then pass to the group of catalyst towers (10). These towers are arranged so that the vapors pass downwards through 3 of them in series, the fourth tower being available for regeneration while the other three are in operation. The piping and valves are so arranged that each tower in turn can be used for the first admission of the hot vapor; in this way the operation of the towers can be rotated so that the tower containing the most highly spent catalyst can be taken out of service when the freshly regenerated tower is put into service.

From the catalyst towers the material, still in vapor form, passes through condenser (11) into distillate receiver (12). The liquid condensate is pumped by charge pump (13) into depropanizer column (14), where materials lighter than butane are separated from the product and are discarded. This column is refluxed in a conventional manner; reboiler heat is supplied by steam.

The bottoms from this column pass through pipe (15), to stabilizer column (16), where materials too light to retain in the finished gasoline are taken overhead and returned to storage tank (1) for recycling through the entire process.

The bottoms from stabilizer (16) and the bottoms from debutanizer (6) combined run to gasoline fractionating column (17), where the materials which are too heavy for the final product are separated as bottoms, the finished product being taken overhead, condensed and run to storage.

FIGURE 5

CHARGE								
Comp.	Cubic Feet	Percent by Wt.	Lbs.	*Raw Yield Gals.	Finished Yield Gals.	Yield Lbs.	Yield Percent Total	Yield Percent Butane
C_3H_8....	31,000	56.6	3,600	.....	.....	.....	.....	.....
C_4H_{10}...	18,000	43.4	2,758	.....	.....	.....	.....	.....
			6,358	480	408	2,460	38.7	89.3
C_3H_8....	143,000	61.5	16,620	.....	.....	.....	.....	.....
C_4H_{10}...	68,000	38.5	10,410	.....	.....	.....	.....	.....
			27,030	2,030	1,725	10,410	38.5	100.0

*Approximately 63.5° A.P.I., 500° E. P. Raw Poly liquid, losing approximately 15% in reducing E. P. to 440° and clay treating.

The process of regenerating the catalyst towers consists of passing through them products of combustion from a gas fire under control-conditions of temperature, pressure, and water vapor saturation. This requires an air compressor for the necessary supply of air, a small pressure retort in which the combustion takes place, scrubbing equipment for removing carbon dioxide from the products of combustion, and a small auxiliary air heating furnace for controlling the temperature of the air passed to the catalyst towers.

The product from any of these processes must be

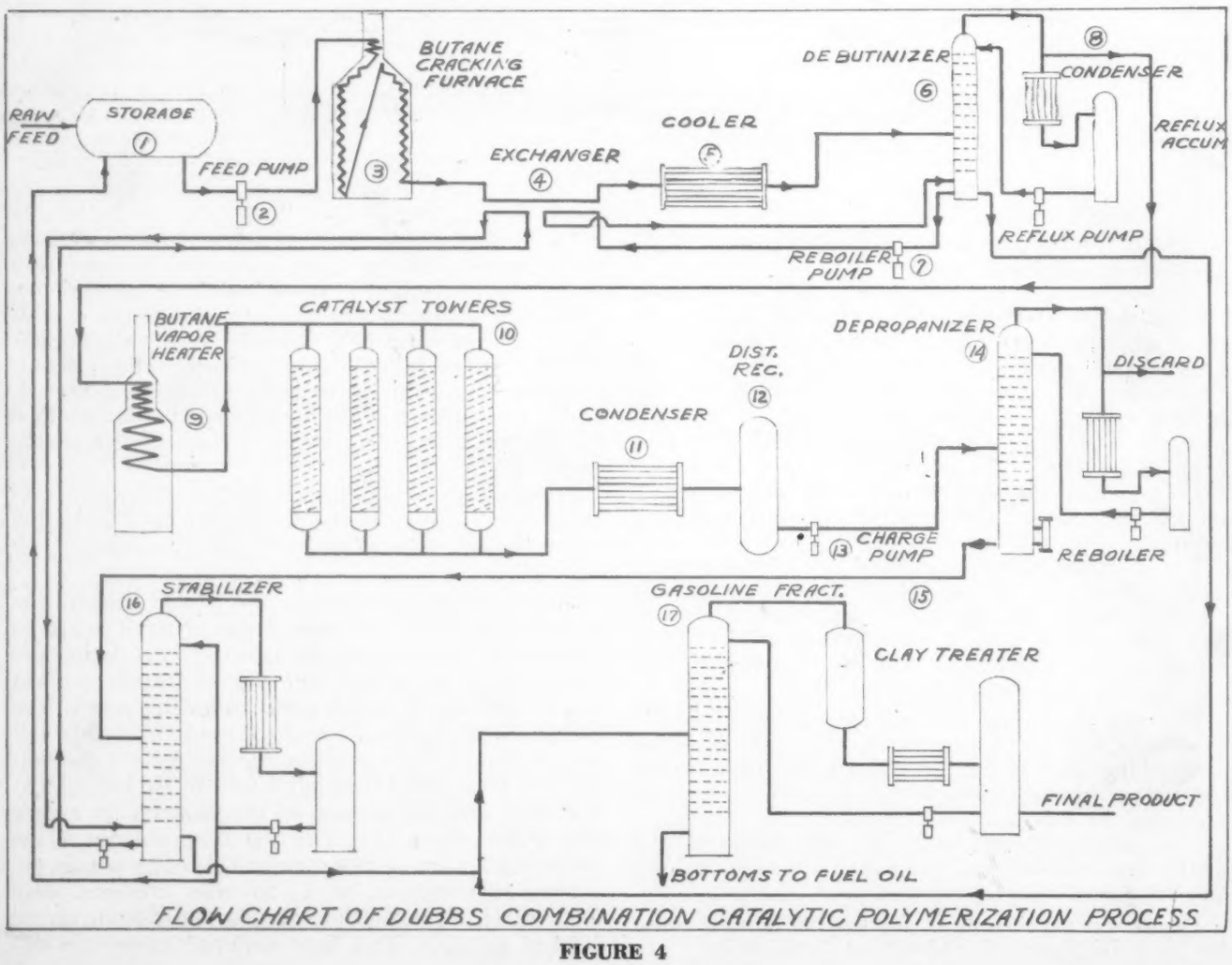


FIGURE 4

treated for gum and color stability, and for sulphur if present. Vapor-phase clay treatment has been found satisfactory for gum and color stability; sulphur can usually be controlled by a strong caustic wash, or by several of the well-known standard sulphur treatments.

YIELDS

An analysis of yields for the Unitary Thermal Process is given in Carey's article in the December 1936, issue of REFINER & NATURAL GASOLINE MANUFACTURER. He presents two cases showing the results from feeding propane-butane mixtures; the tabulation, Figure 5, is based on his data.

The above figures indicate a net yield of something like 35 to 40 percent by weight of the feed can be expected from a fairly representative feed stock taken from a natural gasoline stabilizer. They also indicate that some appreciable conversion of propane must occur in this process, since the feed stock containing the larger percentage of propane shows the larger percentage of yield, referred to the quantity of butane in the feed.

The Shamrock Dubbs plant is being operated on practically pure fractionated butane, substantially free of propane. Under the most favorable operating conditions the yield of finished product is about 0.35 gallon per gallon of raw butane charged, indicating a recovery of about 45 percent on the weight basis. The conversion of propane is felt to be so low by the advocates of this process as to not warrant the additional plant capacity required to handle it.

NATURE OF PRODUCT

Figure 6 presents in condensed form the principal properties of the product. Its chief value lies in the qualities of high octane value and high volatility. These properties make the poly product particularly interesting for the manufacture of aviation fuels. The blending value for raising the octane number of other types of gasolines depends, of course, on the nature of the base stock and on the blending ratio. In one case blending about 25 percent by volume of poly liquid with a straight-run gasoline of 40 octane number, the effective blending value runs from 105 to 110 octane number. In general, the higher the octane number of the base stock and the higher the percentage of poly liquid added, the smaller the effective octane number of the poly.

PLANT INVESTMENT

It is difficult to give anything but quite general figures on the total investment required for building a polymerization plant, on account of the large number of variables which may affect the cost of any particular project.

Assuming a supply of raw material is available for the feed, the cost of a Dubbs plant to handle 1000 barrels per day of raw feed will run around $300,000 exclusive of storage facilities for producing about 800 boiler horsepower of steam and for providing the compressed air required for the regeneration of the catalyst towers. The cost of a Polymerization Process Corporation plant will probably run about the same, although no definite figures are available covering such a plant to treat straight natural gasoline stabilizer discard.

The cost of the installation required to provide the feed stock will, of course, vary widely with plant conditions. It may be necessary to greatly increase the oil-circulating capacity of the gasoline plant in order to get the necessary extraction of butane or butane-propane. This may mean doubling the gasoline plant facilities, or more. In any event, a considerable investment is necessary in equipment to capture and prepare liquid butane from the plant vent vapors. In the case of the Shamrock Dubbs plant built last winter, the cost of the plant modifications required to provide a feed of 1000 barrels per day of fractionated butane was approximately equal to the cost of the polymerization unit itself.

The cost for larger units, will, of coures, not go up in direct ratio with the capacity—for example, a plant to handle 2000 barrels per day of raw feed would probably cost not over 150 percent of the very rough figures given above.

FIGURE 6

Physical Properties of Typical Finished Poly Product

A.S.T.M. Dist.	General Qualities
I.B.P..... 99° F. 5 percent.. 118° F. 10 percent.. 124° F. 20 percent.. 135° F. 30 percent.. 146° F. 40 percent.. 158° F. 50 percent.. 174° F. 60 percent.. 192° F. 70 percent.. 214° F. 80 percent.. 251° F. 90 percent.. 316° F. 95 percent.. 374° F. E.P..... 405° F. Percent Rec. 98% Res..... 1% Loss..... 1% Reid V.P.... 9.2 lb	1. **High Volatility**—40% over at 158°, against 20–25% for ordinary gasoline. 2. **High Octane Number**—80 to 85 ON straight; blending value up to 110 depending on ratio and blending stock. 3. **Ease of Treating**—Vapor phase clay treats to 30 plus stable color and satisfactory gum (10 mgm/100 cc). 4. **Composition**—Predominantly paraffinic hydrocarbons from paraffin feed (propane and butane). Product averages 62 to 65° A.P.I. gravity.

FIGURE 7

	Daily Propane-Butane Feed	
	319,200 Gals.	152,000 Gals.
	Daily Production	
	2,100 Bbls.	1,000 Bbls. (Est.)
Direct Operating Cost per calendar day:		
Operating labor	$80.00	$80.00
Operating supplies	5.00	5.00
Maintenance (@ 4% annum on investment)	137.00	93.00
Fuel, @ 80¢ bbl	243.00	162.00
Steam @ 30¢ /1000 lb	23.00	16.00
Power @ ¾¢ /KWH	412.00	274.00
Water, @ 1¢ /1000 gals	117.00	78.00
General Expense	30.00	20.00
Total Operating Cost /Day	$1,047.00	$728.00
Debit:		
Net Charge, on basis 37% net yield by weight, evaluating liquefied propane-butane charge at 1¢ /gal. fuel value and cost of preparation	$3,192.00	$1,520.00
Direct Operating Cost, as above	1,047.00	728.00
Fixed Charges, basis—Interest 5%	.....	.....
Obsolescence and Depreciation 20%	.....	.....
Taxes and Insurance 2%	.....	.....
Total Fixed Charges 27%	.....	.....
2,100 Barrel Plant Investment...$1,250,000	925.00	.....
1,000 Barrel Plant Investment... 833,000	.....	616.00
Total Debits	$5,164.00	$2,864.00
Credit: Gas Oil produced 232 barrels @ $1.30	301.00	.....
Gas Oil produced.....110 barrels @ $1.30	.....	144.00
Net Total Cost per Day	$4,863.00	$2,720.00
Net Cost /gal. of Poly gasoline	5.51¢	6.48¢

COSTS OF PRODUCTION

A cost analysis for operation of the Unitary Thermal process is presented in Figure 7. The figures for direct operating costs are based on a similar analysis given in Keith and Ward's article in the November 28, 1935 issue of Oil and Gas Journal. The figures in that article are for a plant producing 2100 barrels per day of product, operating on refinery gas con-

taining 22.3 percent of unsaturates; the same operating cost figures were used in the first column of Figure 7. The figures for the 1000-barrel plant are based on the assumption that most items of operating cost, also the plant investment, would be about two thirds of the figures for the larger plant.

In this analysis of costs there are two items which may be open to question.

The first of these is the value of 1 cent per gallon placed on the charging stock. It is felt that this is a reasonable and conservative value based on average operating conditions; however, if there is any market for the butane or propane-butane mixture as such, this value would be in most cases much too low.

The second item which may be open to question is the rather high charge of 20 percent for obsolescence and depreciation. It is felt that, in the present state of the art, this rate is justified for two reasons. In the first place, a good deal of the equipment is required to operate under rather extreme conditions of pressure and temperature, which lead to rapid deterioration. Secondly, it is felt that future developments are likely to make plants, built according to present ideas, obsolete to a greater or less degree in a comparatively short time.

As shown by the final figures in Figure 7, assuming the reasonable accuracy of the detail costs presented the net cost at the plant of the finished poly gasoline is about 1½ cents per gallon for a plant producing around 2000 barrels per day, and about 6½ cents per gallon for a plant producing 1000 barrels per day. These plants would require a raw feed of about 320,000 gallons per day and 152,000 gallons per day, respectively.

It should be noted that the figures presented are based on the straight thermal process, where mixtures of propane and butane similar to those presented in Figure 5, are charged to the unit. If substantially pure fractionated butane is charged, as in the Dubbs process, the amount of butane must be increased correspondingly to produce the same total final yields. I have shown that the yield from typical butane-propane mixtures is about 37 percent by weight, whereas the yield from straight butane feed through the Dubbs process is about 45 percent by weight. This would mean that for an equal yield of final product, the total weight of straight butane charged to the Dubbs process would be only about 82 percent of the total weight of butane-propane mixture required for the Thermal process; however the amount of butane itself required for the Dubbs process feed would be just about double the amount of butane required in the mixed feed to the thermal process, for the same total amount of final product.

ECONOMICS

The question of whether or not a polymerization unit will pay is purely a question of determining whether the value of the material produced at the time and place under consideration exceeds the approximate cost as indicated by the figures presented in Figure 7.

Considering the poly product itself for use straight as motor fuel, there are probably very few locations at the present time where a profit could be shown in competition with other methods of producing motor fuel. However, there may obviously be cases where the value of the poly product for blending purposes may be much greater than its value if used straight for motor fuel. This question must, of course be worked out on the merits of each individual case.

In the case of the Shamrock-Dubbs unit, the owner company had an oil refinery which produced gasoline of exceptionally low octane number, making a base blending stock which could use the peculiar properties of the poly product to greatest advantage. In spite of the fact that the value of the finished motor gasoline at the refinery was in the neighborhood of 4½ cents, the value assignable to the improvement of octane number of the finished product obtained through the use of the poly gasoline indicates a very satisfactory profit on the operation of the poly unit.

REFERENCES

The following list of references covers some of the later articles which have appeared in publications regarding polymerization. As mentioned in the references, several of them, themselves, carry more or less complete bibliographies, particularly the third reference under the general heading of "Process," which carries 145 references.

PROCESS

Unitary Thermal Polymerization Process—J. S. Carey, Refiner & Natural Gasoline Manufacturer, December, 1936. (Full discussion of process and chemistry.)

Motor Fuels of High Octane—Blending Value produced by Thermal Process—P. C. Keithe, Jr. and J. T. Ward, Oil & Gas Journal, November 28, 1935. (Discussion of process and economics. Contains a very complete bibliography of 145 references.)

Polymerization a Major Factor in Tomorrow's Super-Fuels—Gustav Egloff, National Petroleum News, October 14, 1936. (Describes Dubbs Catalytic Process, discusses chemistry—3 references.)

CHEMISTRY

Motor Fuel Isoparaffins by Thermal Gas Polymerization—F. E. Frey—CNGA—1936. (Discussion of experiments and chemistry.)

Industrial and Engineering Chemistry—Frey and Hepp, V-28, p. 1439 (1936).

Products of Polymerization—C. M. Ridgway, C. R. Wagner, H. R. Swanson, Natural Petroleum News, November 4, 1936. (Discussion of thermal process modified for special products—5 references.)

Reactions of Pure Hydrocarbons, by Gustav Egloff, Reinholdt Publishing Corp., 330 W. 42nd St., New York City (1937).

Reforming and Cracking *Aids Michigan Refiner*

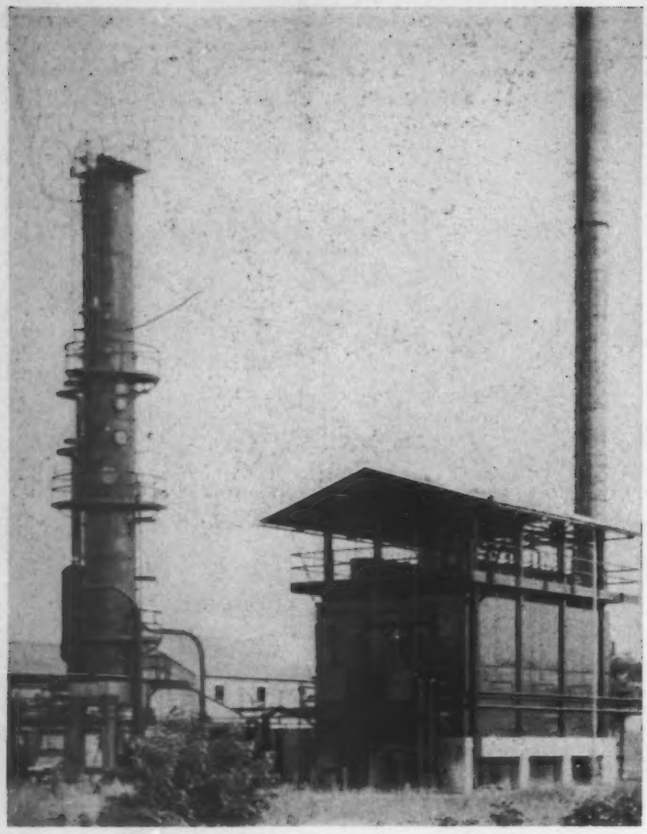
J. C. ALBRIGHT

DUE to the unusually low octane value of straight-run gasoline refined from crude oil produced in Michigan, cracking or reforming is essential if the refiner wishes to market a motor fuel that is satisfactory when used in the modern automobile. Most of the oil in that state carries a large volume of gasoline which may easily be removed in a modern skimming plant, but the octane value of that product, especially when the end-point is around or above 400° F. runs about 16 to 20. Oil recovered from the newest field in Gladwin County has a high percentage of straight-run gasoline having an end point of about 400° F., but the octane value is as low as 16. Obviously, when this material is to be marketed for motor fuel, cracking is necessary.

During the past pear, McClanahan Refineries, Incorporated, at St. Louis, Michigan, revised its refining technique so that motor fuels could be produced along with the more common specialties, such as rubber solvents, Stoddards, V. M. & P., and burning oils. So that a motor fuel could be marketed without adding benzoil, this company built a two-cell Dubbs cracking and reforming furnace with the necessary pumps, columns and stabilizing equipment to produce a motor fuel having an octane of about 69. Several different products from the topping unit have been processed in the high pressure, high temperature addition to the refinery with varying results, depending upon the class and characteristics of the charging stock.

The cracking or reforming unit was erected on the plot occupied by the skimming plant and other equipment, just outside the limits of St. Louis, and on the bank of the Pine river, which is used as a supply of cooling water. The furnace is of the down-fired type utilizing two cells, or firing chambers, each carrying a different set of tubes, one of which is used as the heating bank, and the other used as a soaking bank. Fuel may be either oil or gas, as burners were installed in the flat roof which uses either liquid or gas. After the plant is on stream a sufficient volume of residue gas from the stabilizer-vapor recovery unit can be drawn upon for fuel. The plant was designed for a throughput of 1,250 barrels per day, when charging 400° F. end-point straight-run gasoline, but it has been used for cracking crude, topped crude and gas oils.

Tubes in both sides of the furnace are 2 inches inside



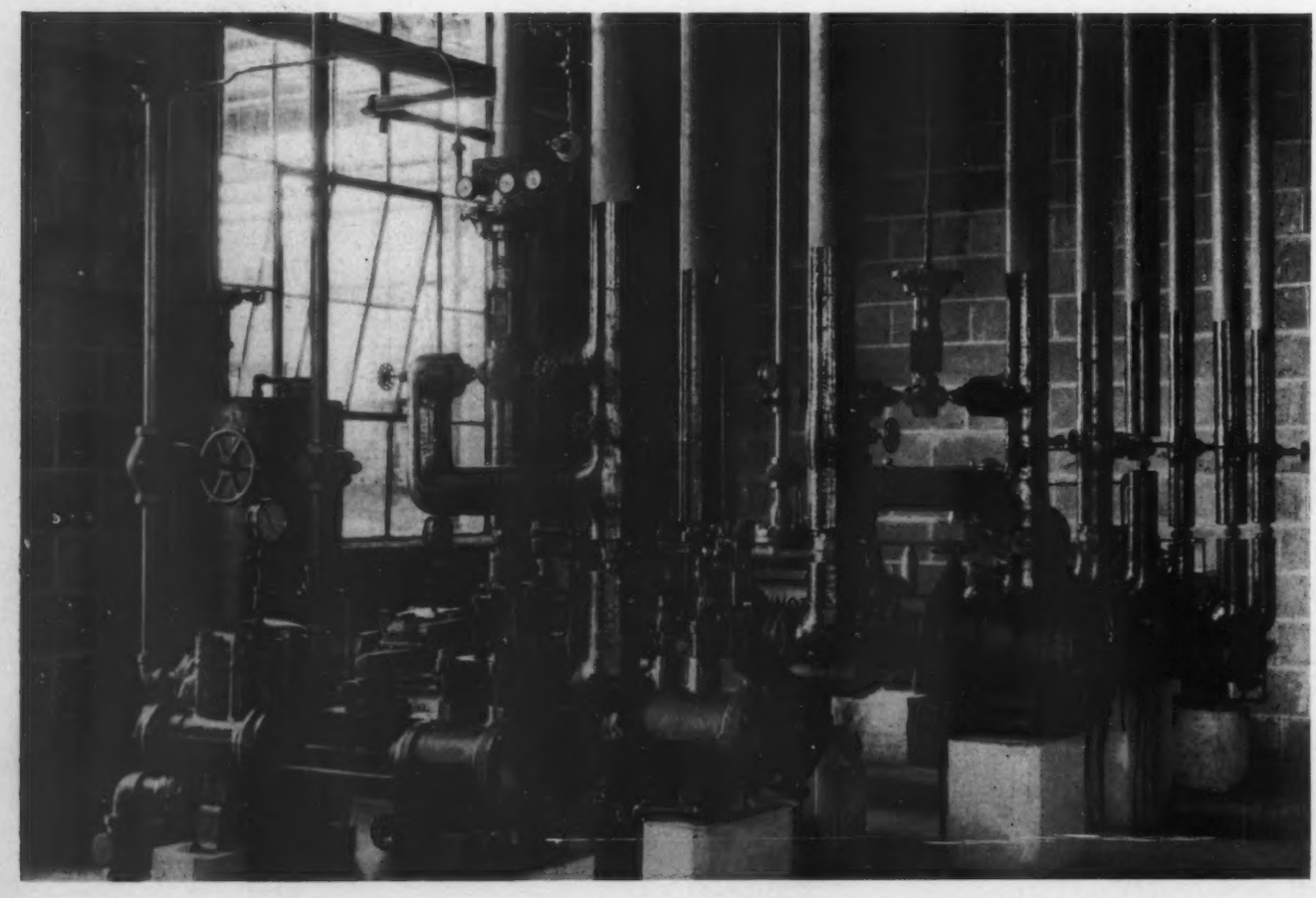
Tower used by McClanahan Refineries, Inc., for reforming naphthas and cracking heavier stocks.

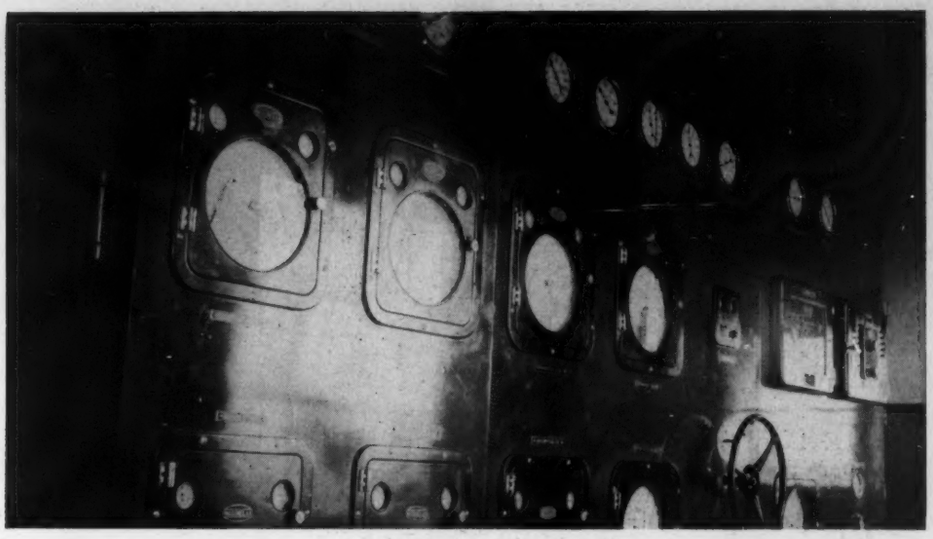
diameter and 2½ inches outside diameter and are 4/6 chrome with ½ percent of molybdenum. They are supported in the center of each cell, one side being made up of a single row, staggered on the heating side, and a double row on the soaking side. Burner adjustment may be made to provide controlled heat input according to the method of operation and the results desired. The transfer line from the soaking side drops down from the furnace outlet and is carried in a concrete conduit to the combination column which was erected a short distance from the heating element.

Charging stock enters the inlet side of the furnace under a pressure of 1,350 pounds, gauge, when straight-run gasoline is being reformed, and leaves the heating section at a temperature of 1,000° F. Due to the flexibility of the furnace, more heat may be put into the charge while passing through the soaking section, or the temperature held at that applied in the cracking section. With straight-run operation, the charge at the transfer point usually carries a temperature of about 1,035° F. Reduction in pressure is obtained through the use of a special automatic regulatory valve on the transfer line where it passes through the concrete conduit. Cracking of the stock is arrested at 750° F. at a point just outside the column. This temperature varies considerably, depending upon the characteristics of the charge and the type of residuum required in the reforming operation.

The combination flash and fractionating column is 63 feet in height and 5 feet in diameter, placed on a 16-foot pedestal, and having a 20-foot section in the lower end which is open, and contains no plates. The column was designed with 16 fractionating plates above

Reflux and control pumps at McClanahan Refineries, Inc., which are used when cracking.





Control Board.

the transfer line entrance nozzle, and was equipped with a side cut section so that heavy oil may be produced for absorbing the vapors passing through the stabilizer and gasoline vapors from the accumulator drum. The column was designed with the empty lower section so future additions may be made to include full-flashing cracking operation with the addition of other columns and equipment necessary.

With 400 end point straight-run reforming operation, refluxing for top column control is obtained by pumping condensate from the accumulator drum back over the top in the conventional manner, and residuum obtained equals about 1 percent of the charge. This is withdrawn from the base of the column and used for fuel. Liquefied overhead is collected in the usual type of accumulator drum and passed to further processes for finishing. Control of all operations is obtained from the panel which carries the indicating and recording instruments. Pumping is done with both steam and gas engine-driven units. Reflux, pumping out, finished products and stabilizing operation are carried out with steam-driven pumps, while the charge is handled by a gas engine-driven horizontal engine, all of which are housed in one building near the furnace and column.

Plant control was made more positive by placing various units in convenient places, such as drop-out controls and others, so that any operation may be changed quickly and without loss of time. The drop-out panel was placed just outside the control room and on the protected side of the building, equipped with quick open-and-shut valves on lines from all points in the plant. Sampling is done through a concentrated bank of valves and liquid lines on both the cracking-reforming unit and the stabilizing-vapor recovery plant.

Condensate from the fractionating tower, which is removed from the overhead line, is pumped through adequate exchangers and to the stabilizer for the removal of excess butane and propanes. This unit is of conventional design, carrying exchangers, pumps, reboiler and condensers. Gasoline removed from the base of the fractionating column is treated by washing with caustic and finished by contacting with doctor solution, after which it is pumped to storage and finished with an inhibitor for gum prevention.

The vapors from the accumulator drum and from overhead on the stabilizer are passed through a conventional oil absorber to remove desirable fractions which may be carried over as vapors or by mechanical action of the gases. The liquid used for absorption cut from the side of the fractionating column has a sufficiently low end point that it may be pumped with the cracked or reformed product directly to the stabilizer for recovery of both the oil and absorbed gasoline.

A stream analysis of finished gasoline manufactured from ordinary straight run having an octane of 25 shows the following:

I. B. F.	96° F.
10 percent	130° F.
20 percent	152° F.
30 percent	174° F.
40 percent	196° F.
50 percent	222° F.
60 percent	248° F.
70 percent	276° F.
80 percent	316° F.
90 percent	372° F.
E. P.	400° F.
V. P.	8½ lbs., Reid.
Octane	68/69
Induction point	240 minutes.
Gum	5 mg.

Access to a large volume of water makes it possible to pump cooling water directly from this stream through inclosed shell-and-tube condensers and drop the hot water back downstream into the river again. The water is produced from a well, excavated beside the river bank so that an inexhaustible amount is always available, percolating through the sandy type of soil as a natural filter. It is picked up by a Diesel-driven centrifugal pump, which was built for both Diesel and motor drive. Either may be used, and if the engine fails to function, an automatic device immediately closes the circuit from the high line and operations are continued with electricity as the power used.

Steam for the plant, both the skimming, special products and cracking is produced with a water tube unit fired with either gas or oil. Burners were installed in this unit for use of either type of fuel. Superheated steam for processing the charge is obtained by passing saturated steam through superheating coils in the furnace so that dry steam may be used for purposes requiring this type of material.

Various operations have been accomplished with this combination cracking-reforming unit, and the entire plant was designed with the idea of converting directly to a conventional cracking plant, or a combination cracking-reforming which might include flash and reaction chambers, additional pumps and accessories without a prolonged shut-down when converting.

Proving Procedure

for Positive Liquid Displacement Meters for Measurement of Natural Gasoline

T. R. BEAUCHAMP
*The Texas Company**

SOME three years ago Mr. C. D. Gard read a paper before this organization the subject of which was "Measurement of Natural Gasoline by Meter." In this paper Mr. Gard brought out many interesting points relative to the disadvantages of storage tanks used for the measurement of liquefied petroleum products which includes natural gasoline. During the last several years a great deal of advancement has been made in the development of accurate and reliable positive liquid displacement meters. This development has induced the trend toward their use for the measurement and sale of natural gasoline. The extended use of metering would greatly reduce the fire hazards in gasoline plants, due to small storage requirements, and would also result in savings of both material and labor by reduction of expensive storage equipment and labor required for gauging. However, the oil industry has been slow to take advantage of this simple method of measurement due to the lack of an adequate, quick and reliable method of testing the accuracy of these meters in service.

It was with these thoughts in mind that the technical committee decided to appoint a sub-committee to investigate and submit recommendations for a proving procedure to make it possible for the industry to adopt metering as a standard method of measurement in the sales and transfers of natural gasoline.

During the last several years, both Union Oil Company and The Texas Company, being interested in the sale of natural gasoline by metered volume, have spent considerable time and material in the development of satisfactory proving equipment and procedures. The committee conducted a thorough study of the equipment and procedures as developed by these two companies. One system requires a greater investment for equipment than the other but in turn allows for faster operation. Due to the accuracy obtained through the use of both types of proving equipment, the two systems as developed by their respective companies, together with im-

* Presented before the annual meeting of the California Natural Gasoline Association, November 16, 1937, Los Angeles, California.

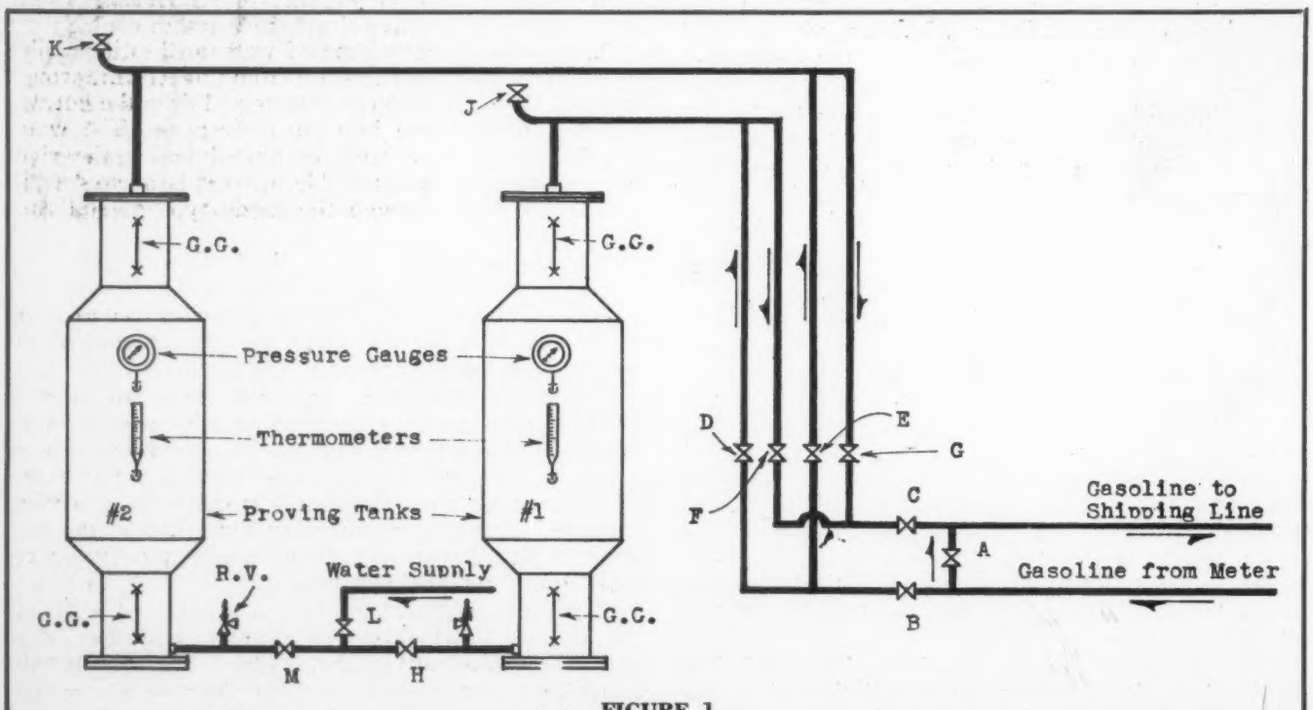
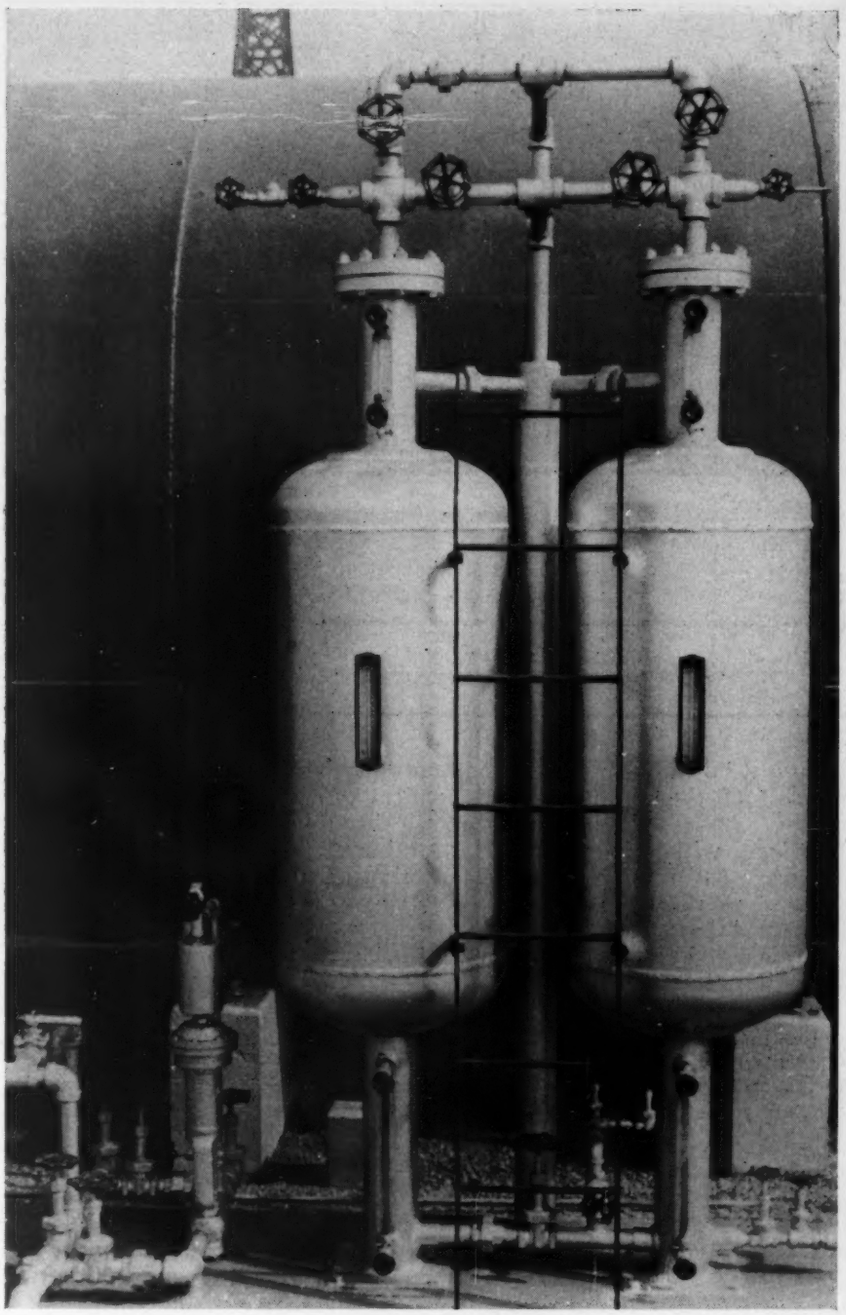
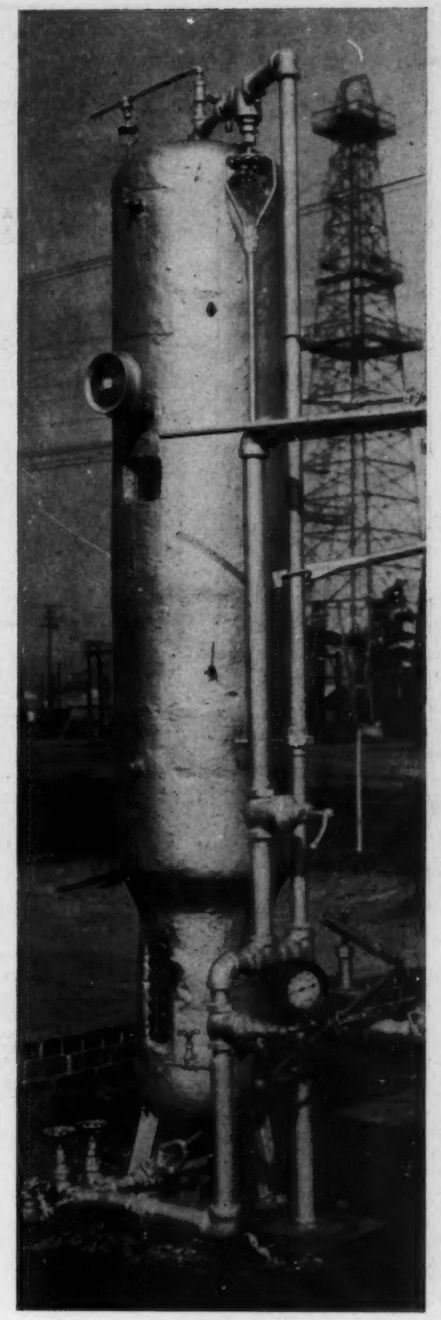


FIGURE 1
Type A Apparatus.



TYPE A



TYPE B

provements and refinements made by the committee, will be presented in a bulletin and will be designated as apparatus "A" and apparatus "B".

The proving method consists essentially of gauging a metered volume of gasoline in a calibrated container. The gasoline passes through the meter at normal operating conditions and into the proving tank where the volume is accurately determined. The test is conducted under sufficient pressure to avoid vaporization and employs the downward displacement of water. The two types of apparatus both utilize the same principles of operation. The essential difference between the two is that the one designated as type "A" makes use of two tanks, while the other designated as type "B" makes use of one tank.

Tank "A" apparatus (see Figure 1) consists of two tanks of suitable size equipped with thermometers, gauge glasses, pressure gauges and necessary connections. The two tanks are connected together at the bottom to form a U tube, and so manifolded at the top that gasoline can be pumped into one and forced out of the other and vice versa, to permit the use of both tanks for gauging. This is accomplished by maintaining a volume of water equivalent to the capacity of one tank in one side of the U tube, the other side being filled with gasoline. In proving, gasoline is pumped through the top connection into the tank containing the water, the displaced water going into, and forcing the gasoline out of the opposite tank.

Type "B" apparatus (see Figures 2 and 3) consists of a single tank equipped with a thermometer gauge glass, pressure gauge and necessary connections. The tank is so connected that it can be completely filled with water. In proving, gasoline is pumped into the tank through a top connection

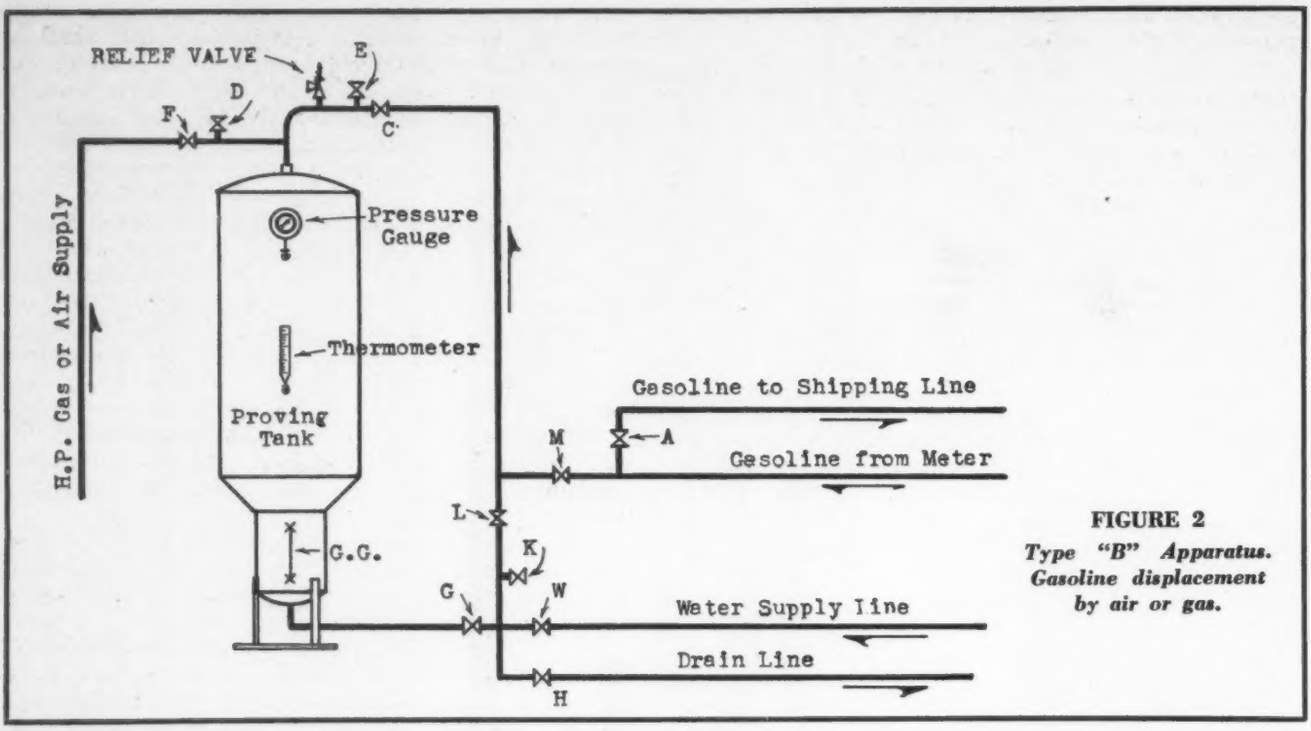


FIGURE 2
Type "B" Apparatus. Gasoline displacement by air or gas.

forcing the water out of the tank through a bottom drain. Provision is also made for removal of the gasoline.

Each tank shall be cylindrical in shape with bumped or conical heads to which a neck (type "B") or necks (type "A") of smaller diameter than the tank shall be attached and made an integral part of the tank. It is essential that the construction be such so that the possible trapping of any liquid or vapor in the tank will be eliminated. To insure sufficient rigidity, the tanks shall be constructed with a minimum thickness of quarter-inch metal and designed according to existing codes, for a minimum working pressure of 75 pounds per square inch gauge. The size of each proving tank shall be equivalent to at least twice the delivery rate per minute of the meter. The diameter of each neck shall be such that one tenth of an inch vertical height represents not more than .05 percent of total tank volume. The length of the neck shall be sufficient to accommodate a 12-inch minimum length gauge glass. Each tank, including the neck, is to be covered with some standard form of insulating material to a thickness of not less than ¾-inch.

A gauge board marked off in divisions of equal gallons and increments of a gallon, the smallest division not to exceed .05 percent of total tank volume, shall be permanently mounted in such a manner that it is parallel and in close proximity to each gauge glass. For type "A" apparatus, the zero point shall be taken as the top marking of the upper gauge board. The lower marking of the bottom gauge board shall represent the total calibrated capacity of the tank. The zero point of type "B" apparatus will be explained later. The readings on the board shall be of a permanent nature and may be baked enamel, inscribed in metal, or printed on cloth tape suitably coated to protect it from exposure and mounted on wood or metal stripping.

Each tank shall be equipped with one standard thermometer installed in the center of the tank. Standard thermometers for measuring the temperature of the contents of the tank may be either the industrial or chemical type. The thermometer shall be installed directly through the tank shell with sufficient stem for a minimum immersion of 12 inches, unless such immersion is greater than the radius of the tank, in which case the stem shall extend to the center of the tank.

Calibration of type "A" proving tanks is undertaken after vessels are set up, tested for leaks and secured in a permanent vertical position. Water is measured into the tanks by bucketing with one- and five-gallon buckets tested and sealed by the Bureau of Weights and Measures, the one gallon bucket being used for the necks and the larger measure for the balance of the tank. It is necessary to note the temperature of each bucket of water and make volumetric adjustment for the thermal expansion of the bucket itself. Upon completion of the filling of the tank the temperature of the water in the tank is observed and permanently recorded as the calibration temperature.

In order to avoid boring you more than necessary with a long, drawn out, alphabetical description of how to prove a meter, will attempt to describe the highlights of it as follows:

Assuming the proving tanks to be empty, with vent and equalizing valves upon, introduce enough water into the system to bring the level to the upper portion of lower gauge glasses. Now close equalizing valve "M" and continue filling tank No. 1 until water level reaches mid section of the upper gauge glass. Fill the balance of tank No. 1, tank No. 2 and adjacent piping with gasoline, displacing the air and vapor through vent valves. With equalizing valves and lines from meter open to tank No. 1 and all other valves closed, record the pressure on system high gauge and meter reading. Next, open outlet lines from tank No. 2 and main line valve "C". allowing gasoline to enter tank No. 1 at normal operating rate and pressure. Close main line outlet valve "C" when gasoline has appeared in the lower

gauge glass. Record meter reading, low gauge and temperature of the gasoline in tank No. 1.

The calibration of type "B" apparatus is essentially the same as for type "A", except that the upper piping is included as part of the tank and for convenience, the water is bucketed out. The upper piping as well as the tank must be completely full of water. This is accomplished by introducing water at the base of tank and venting at top. In proving type "B" apparatus, gasoline is introduced at the top and the water drained from the base through a rate valve, maintaining normal operating pressure. The same information is recorded as for apparatus "A" except that no starting gauge is necessary as the zero point on this type is always the same (i.e. tank and upper piping completely full of water). The same correction factors are applied as for type "A" to determine the net volume and percent of error. At the conclusion of the test the gasoline is removed from the proving tank by displacement with water, air or gas, and the apparatus is then ready for the next test. Tests shall be repeated until two or more consecutive tests check within the tolerance agreed upon.

The temperature correction for reducing the volume of the gasoline to 60° F., shall be made by the use of factors given in the A.S.T.M. Standard D-206-36. For petroleum liquids with an A.P.I. gravity of 100° or higher, correction factors shall be obtained from the Bureau of Standards Bulletin No. 97. This correction is to be applied to both the volume of gasoline gauged in the proving tank and the corresponding metered volume, unless the meter used is one of the temperature compensating type, in which case no correction factor shall be applied to the metered volume.

The calibrated capacity of each proving tank is the capacity as determined with the tank shell standing at the same temperature as the water used in the calibration test. This temperature has been designated as the calibration temperature and shall be used as a base for corrections to tank capacity due to the thermal expansion of the shell. If the temperature of the gasoline during the proving test is different from the calibration temperature, the actual capacity of the tank will be different from the calibrated capacity and the proper corrections must therefore be made. The coefficient of linear expansion of the average mild steel plate is approximately .0000063 per degree F. The coefficient of volumetric expansion would be approximately three times this or .0000189 per degree F. With the calibrated capacity of the proving tank known and the volumetric coefficient of expansion shown above, a table shall be made showing the correction in gallons to be added or subtracted to the calibrated capacity for each degree F., that the gasoline temperature is correspondingly higher or lower than the calibration temperature.

The gauged volume of the gasoline in the proving tanks, for both procedures "A" and "B", is obtained under the normal operating pressure of the meter. At this pressure the capacity of the tank is greater, due to the expansion of the metal, than its actual calibrated capacity determined at atmospheric pressure. Also, the volume occupied by the gasoline becomes less, due to its compressibility, as the operating pressure increases. The volume of the gasoline as gauged must therefore be increased by factors representing these two items in order to determine the net gallonage gauged. Since the two factors are both dependent on, and proportional to, pressure, they may be combined as a single correction factor, the experimental determination of which will be described in the bulletin. The frequency of proving tests, the permissible meter error, and the application of results shall not be construed as a part of the bulletin, but shall be agreed upon by the parties interested in the measurement.

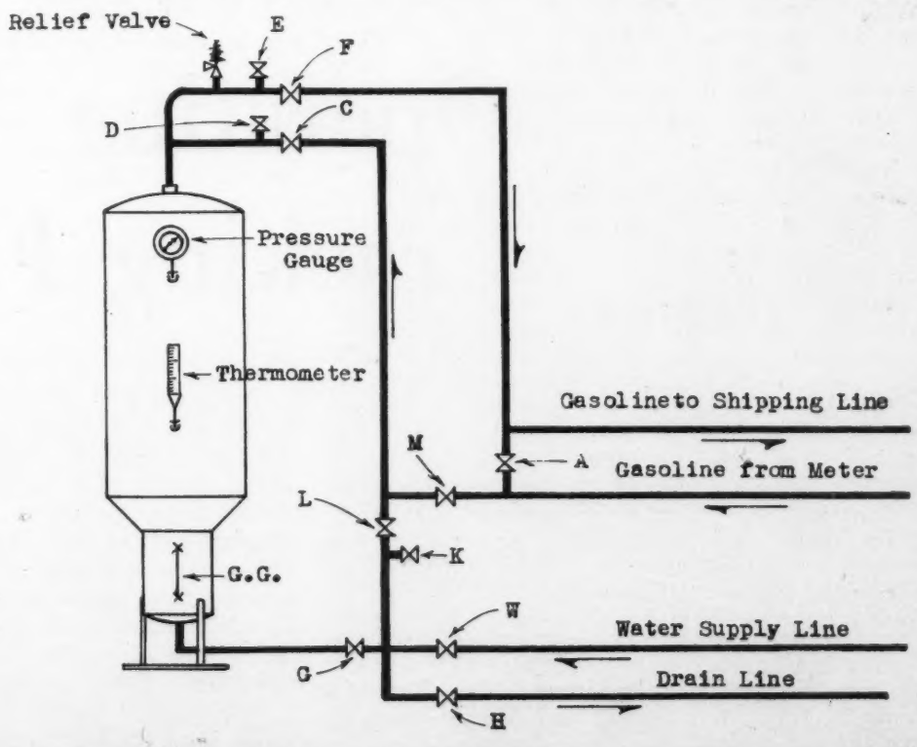


FIGURE 3
Type "B" Apparatus. Gasoline displacement by water.

McMURREY REFINERY

Operating Modern Cracking Facilities

J. C. ALBRIGHT

SHORTLY after the boom began in the East Texas field a plant was built in Tyler, which was at that time one of the largest in that section. Not only was the size sufficient to process around 10,000 barrels of East Texas crude daily, but it was one of the few refineries ever built that operated without boilers. Power for pumps and other equipment was secured from the electric company serving that district, and process steam was generated by introducing a controlled amount of water into the columns and other equipment that required agitation and the vapor pressure provided by steam. (See REFINER, Volume 10, July, 1931, page 71 and August, page 99, where the early plant was fully described.)

The plant was operated in this manner for a number of years, utilizing an unusual design of heater. Two years ago, the plant was partly revamped with the inclusion of a modern, up-to-date tube heater, designed to operate as a viscosity breaker. During the first part of 1937, the entire refinery was rebuilt, old towers removed, cooling towers expanded and new fractionating equipment installed, together with an additional furnace and facilities for cracking East Texas topped crude. The plant is now operated by McMurrey Refining Company, present owners.

The original layout of the plant was followed partially, with the flow of the oil through the plant from

one end to another, beginning with the fresh oil at one end, and ending at the other with the heavy oil cracking furnace. The pumping arrangement was followed substantially, by using as many of the original motor-driven pumps as practical.

Two oil field boilers were set in the yard to furnish process steam, and to control fires. A stand-by pump was installed to handle vapor condenser water so that if power went off suddenly, no big rush of uncondensed gases would spread over the plant. Circulation of the light and heavy oil processed in the two furnaces was provided for by Diesel-driven outside piston packed pumps.

Salt is becoming more of a problem every day with refiners processing East Texas crude, due to the encroachment of the salt water level in the wells, particularly on the west side of the field. The amount of salt carried in the oil varies somewhat, but sufficient is present in the crude processed at Tyler to make removal necessary before distillation begins. The crude is picked up from the 80,000-barrel welded crude stock tanks by motor-driven pumps and charged through distillate exchangers, and topped crude exchangers before it enters the salt-settling chamber. Water in varying amounts, depending upon the quantity of salt in the oil, is fed into the stream at the crude charge pump, and follows with the oil through the exchangers to the settling drum. This drum is 10 x 20 feet and is a reaction chamber purchased from a dismantled refinery in the north part of the state.

Crude comparatively free of salt leaves the settling drum and travels to the crude distillation heater, one of the original furnaces erected when the plant was first built. The crude after passing through the tube heater, enters the crude fractionator, a column 7 feet in diameter by 65 feet in height, where several cuts are removed. The column has 18 bubble decks above the crude inlet, and 3 side-to-side pans below the inlet. Three side cuts, together with the overhead stream are removed from the column, varying in distillation range as market demands provide. An additional stripping section for two of the side streams is provided by a two-section column, erected beside the main tower, with liquid removal lines placed in the conventional manner. Topped crude, constituting the bottoms from the column is withdrawn from the base of the column, directed through heat exchangers, and regulated by a flow-controller valve beside the pump room door.

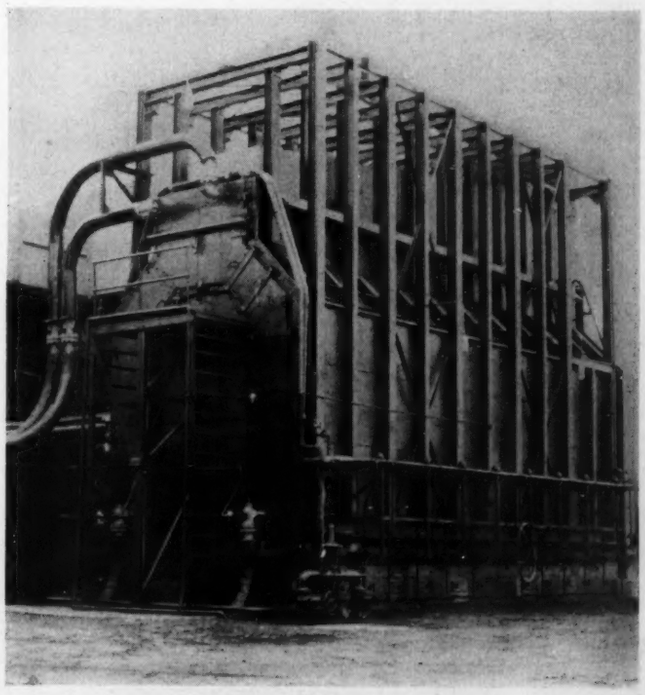
The bottoms are either picked up directly from a working tank, or cooled in submerged four-inch cooling coils and pumped to storage for future use. If the plant practice requires that the topped crude be processed through the cracking unit immediately, the topped crude pump, a centrifugal unit driven by an electric motor, passes the charge to the section of the main fractionating tower. A Diesel-driven hot-oil pump picks up this material from the base of the fractionating column and delivers it in a split stream to the new furnace, an upshot, two-cell unit with parallel flow tubes.

This furnace, completed during the early summer of 1937, has a tube cell on each side, and 30,000,000 B.t.u. input capacity. The tubes, both in the radiant and convection sections, are low chrome plus a small percentage of molybdenum, with 4/6 chrome headers. The convection section was filled with 2¾-inch I.D. tubes, and the radiant section with 2½-inch I. D. tubes, both sections have tubes 34 feet in length. The firing arrangement consists of both gas and oil burners, with the flames sweeping the inner walls, or flaring outward against the tubes, as the case may be, depending upon the operating procedure of the plant. The burner irons next the inner wall are adjustable to direct the heat to the point where it will best serve the purpose intended.

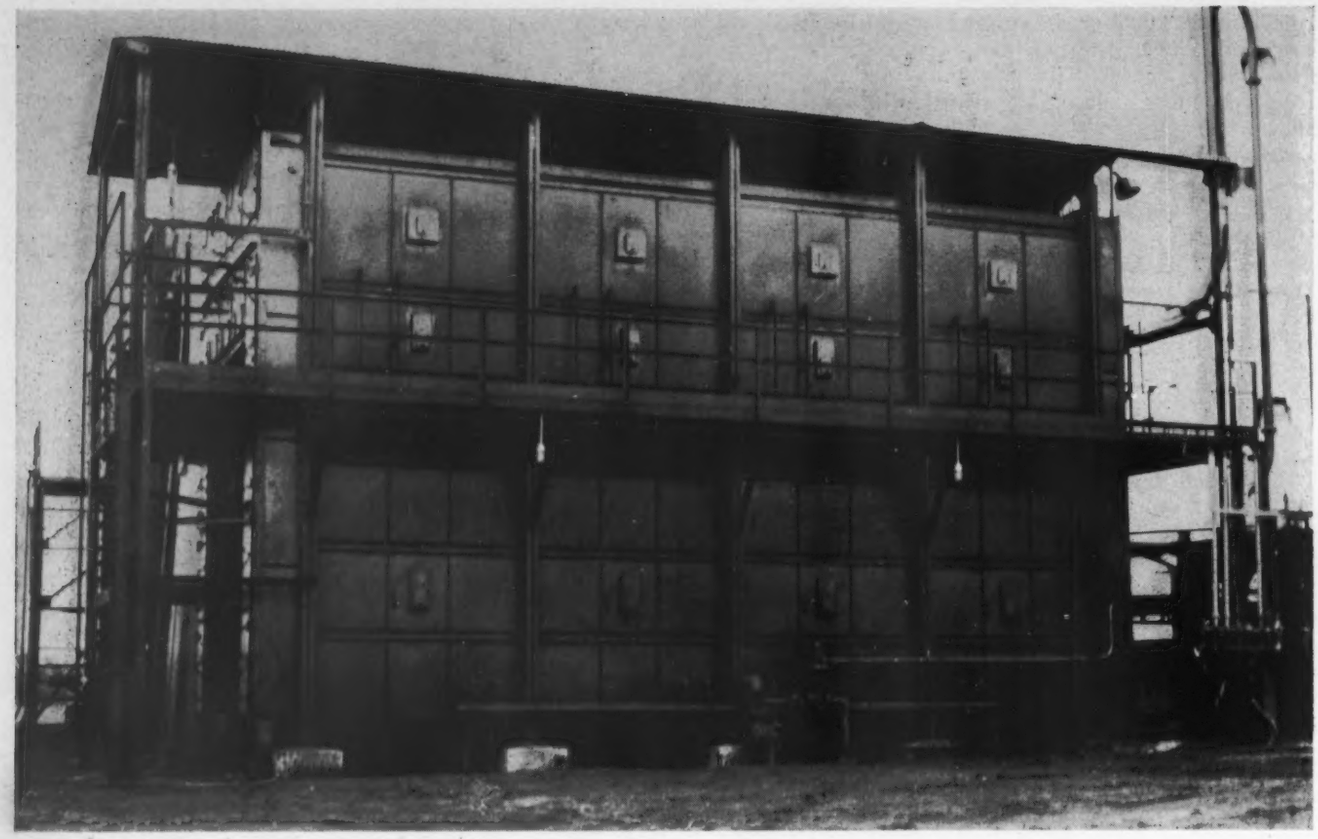
The light oil furnace was built prior to the present rebuilding program, and is now used as a light oil cracking furnace, handling a 26° A.P.I., 600° F. end point charge. The charge for this furnace is taken from the main fractionating column between the eleventh and the twelfth trays, where an eight foot section is provided as an accumulator section for this type of material. The liquid drawn from the column at this point is split three ways; part to the light oil cracking charge pump, part to the finished gasoline stabilizer reboiler and part to the top of the vapor recovery system absorber as absorption oil. A Diesel-driven hot oil pump, similar in design to the heavy oil charge pump takes suction from the accumulator pan and delivers a predetermined amount to the light oil cracking furnace.

The furnace has a 30,000,000 B.t.u. input, the same as the newer heavy oil heater, but contains 3-inch I.D. tubes, 38 feet in length, carbon steel with ½ percent molybdenum and 38 feet in length. The light oil charge entering the furnace has a temperature of 575° F., and a transfer temperature of 1015° F. The charge to the heavy oil furnace handles a 19° A.P.I. material with a temperature of 690° F. on the inlet to the Dubbs double cell heater, and a transfer temperature of 910° F. Both streams enter a common reaction chamber, 5 feet in diameter and 40 feet in height, but through separate entrance nozzles. The pressure on this chamber is maintained at 325 pounds, and the temperatrue of the combined streams is 900° F.

The material flows out from the reaction chamber through a slide valve to the entrance of the flash



Upshot furnace used for heavy oil cracking in McMurrey plant



Heater used to process light oil in Dubbs cracker

chamber, which is operated at a pressure of 70 pounds, gauge, and carries a temperature of 810° F. at the bottom of the column. Fuel is withdrawn from the base of the column, through a float valve, which maintains an extreme low level in the chamber, and an additional valve, near the control room door controls the flow of oil to the coolers. The grade of oil normally manufactured has the following specifications:

A. P. I. Gravity	6.8° A. P. I.
Viscosity	190 sec. Furol at 122° F.
Flash	225° F.
Fire	315° F.
BS&W	2/10 percent

The vapors leave the 8-foot, 6-inch by 50-foot flash chamber, and flow to the main column, which is 8 x 68 feet, containing 18 bubble decks and 8 stripping sections. The cuts taken from this column include the light oil cracking charge, and the overhead distillate, a 390° F. end point gasoline, which is condensed in atmospheric sections and flows to the accumulator drum. If blending is desired with straight-run gasoline, the distillate removed from the top of the crude fractionating column is reduced to about 385° F. end point, so the octane rating of the combined fuel will be satisfactory. When blending is done, the straight-run and the cracked distillate are mixed before stabilizing, and then fed to the column to reduce the vapor pressure to that desired. Summer pressures average about 8 pounds, Reid, and winter about 11 pounds. The gravity of the blend usually runs about 61.2° A.P.I., and the octane rating from 69.1 to 69.2.

As the bulk of the pumps, outside the hot charge units, are operated by electric motors, extreme care is taken to prevent damage when and if an electric storm occurs. Circulation through the cracking heaters can be maintained by the Diesel engines, but as the water is circulated by motors also, provisions were made to include a steam turbine on the opposite end of the water pump shaft on the condensate cooling unit. The governors of the turbine have been adjusted so no steam will be consumed while the pump is being operated at the required speed, but when the speed drops appreciably, the turbine takes hold and operates the pump until the power is on the line again.

To accommodate the added cooling of the plant after the Dubbs cracking unit was installed, the cooling tower was enlarged to 29 feet, 6 inches wide and 180 feet in length, with a capacity of 5200 gallons of water per minute.

Gas not condensed in the distillate coolers is piped to the absorber where the desired fractions are recovered by oil absorption, and the rich oil pumped back to the fractionating column for distillation. The residue gas is then piped to a gas holder from which it is taken for fuel in the boilers, the stills and other purposes as needed. If the volume of gas is not sufficient to furnish fuel for all burners, part of the system is fired with fuel oil, as both cracking stills, the crude pipe still and the two boilers were equipped with both gas and oil burners.

Straight-run and blended motor fuel, as well as straight cracked distillate, when produced separately, are pumped, after cooling, to a doctor sweetening plant for finishing before shipment.

The plant was designed by engineers of Universal Oil Products Company, but the actual erection and building of the various units was done with company men, who had been operators on the old plant, and after the unit was completed and on stream, they began again as operators.

1936 and 1937

Active Years for California Natural Gas Industry

W. W. ROBINSON
The Texas Company

THE membership of the California Natural Gasoline Association evidenced deep interest in the developments of the industry during the past year when over 200 were in attendance at the annual meeting in Los Angeles, December 9, to hear the story of "1937 on Parade."

Preceding the discussion of recent events in the field, was a dinner meeting presided over by J. C. Burks, O. C. Field Gasoline Corporation, president of the association. Upon adjournment to the lecture hall the meeting was turned over to W. W. Robinson, The Texas Company, who presented a brief outline of the status of the industry and future prospects in the field.

Following the general presentation, four speakers told of the construction and operation of the major gasoline plants built this year. The speakers, with projects outlined, were:

C. L. Parkhill—Belridge Plant No. 4 at North Belridge.

M. E. Garrison—Wilmington Absorption Plant, General Petroleum Corporation.

Frank West—South Mountain Gasoline Plant, The Texas Company.

F. W. Wilcox—Rancho Gasoline Corporation plant at Grapevine.

NEW field developments, a sound economic condition, and increasing utilization of natural gasoline are basic factors which have stimulated plant construction and modernization in California's natural gasoline industry during 1936 and 1937, and justify an optimistic outlook for 1938.

Recovering from the 1933 low, natural gasoline production has steadily increased. In 1936, 603,000,000 gallons were produced, which was 11 percent greater than the 545,000,000 produced in 1935. Government figures for the first half of this year indicate that production for 1937 will probably be about 6 percent greater than that for 1936. If the present rate of production continues, the volume of natural gasoline manufactured this year will be close to 615,000,000 gallons, or the largest annual production since 1931.

In its struggle through the 8-year decline which started right after the flush production days of 1929, it is likely that few in the local industry realize that in 1935 and 1936 California contributed fully one third of the natural gasoline produced in the United States. Texas came next with 28 percent and Oklahoma third with 23 percent. There is also every indication that California will occupy an equal position for 1937.

During the past 18 months, the market for natural gasoline has shown a definite widening. By comparing monthly production figures to the volume of stocks on hand at the end of each month for 1935, 1936 and 1937 (to June), it will be noted that there was a large withdrawal from stocks in April last year. Since this withdrawal the average volume of stocks at the end of each month has been close to 2,200,000 gallons, yet natural gasoline production has increased. With stocks continuing to average close to the aforementioned level, the substantial production increase is evidently being absorbed through greater utilization.

Taken as an approximate average for the first 10 months of this year, 92 Pacific Coast natural gasoline plants handled an approximate monthly volume of 31,000,000,000 cubic feet of wet gas to produce approximately 51,000,000 gallons of natural gasoline. Based on federal statistics for October this year, the 5 leading fields in terms of natural gasoline produced are: first, Kettleman Hills, with 14,951,374 gallons; second, Long Beach, with 6,897,052 gallons; third, Santa Fe Springs with 5,207,717 gallons; fourth, Ventura Avenue, with 4,499,981 gallons; and fifth, Huntington Beach, with 3,691,737 gallons.

From 1931 to the early part of 1936, Pacific Coast oil prospecting operations were slowed down by the general business recession, and the overall failure to discover pools of any size. However, as efforts continued, interest in the Los Angeles Basin was attracted to the eastward extension of the old Montebello field. Next, in June, 1936, came the geophysical discovery of the Ten Section field by Shell Oil Company. Following this, interest shifted to the rapid growth of the Wilmington and El Segundo fields. The first of this year Standard Oil Company discovered the Greeley field, and a little over a month ago The Texas Company completed a well which established the North Belridge extension. Close on the heels of these San Joaquin Valley discoveries came Union Oil Company's 11,302-foot well in the Rio Bravo sector, which proved one of the deepest sands in the United States. Following this came Ohio Oil Company's discovery in the Strand area. These Los Angeles Basin and San Joaquin Valley field developments have been characterized by an orderly expansion into which the natural gasoline manufacturer has come with his highly developed art. True, not all newly discovered areas have been

entered by the gasoline industry, but those which have, together with the remodernization done in older fields, reflect a surprising amount of progress when viewed in perspective.

In the East Montebello field, The Texas Company built its 25,000,000 cubic-foot-a-day Plant No. 14; and Universal Consolidated Oil Company its 6,000,000-cubic foot semi-portable unit. With the proving of the El Segundo field, Richfield Oil Company built a 2,000,000-cubic foot plant which has since been enlarged to handle between 16,000,000 and 17,000,000 cubic feet. This plant extracts natural gasoline from a slightly sour gas and removes the sulphur compounds during the rectification of the finished product. The sulphur in the dry gas is removed by the iron oxide process. In this district Ohio Oil Company has recently erected an absorption unit brought over from the Venice field. Gas is being treated at well pressure at present, but the installation of compressors is under way. In the Richfield district West Coast Refining Company has recently completed extensive changes to its plant which included a revision of the compressor plant and the installation of a new vapor compressor.

Of significance in the past year is the increasing trend toward the construction of, or changeover to, high-pressure absorption equipment. Moving northward we find that The Texas Company has erected a two-stage plant to handle gas from its Shiells Canyon development. Due to the development of a deeper zone at Rincon, and the Padre Canyon discovery, Coline Gasoline Company has recently remodeled its plant to include a 500-pound absorption tower, and a new compressor plant. In this same district Western States Gasoline Corporation completely remodernized its 15,000-gallon capacity plant. To El Capitan Shell Oil Company moved its Inglewood plant and modernized it to handle 3,000,000 cubic feet a day at 30-pound pressures.

Going into the San Joaquin Valley we find, almost at the foot of the Ridge Route, Rancho Gasoline Corporation's absorption plant with a capacity of 20,000,000 cubic feet at 450 pounds. And in the new Greeley field is the Standard Gasoline Company's new 450-pound unit with a capacity of 35,000,000 feet daily. No mention of San Joaquin Valley gasoline operations is complete without noting Shell Oil Company's 450-pound 20,000,000 cubic foot plant in the Ten Section field, with its 40-plate stabilizer.

In the North Belridge field we find Belridge Oil & Gas Company's new Plant No. 4 with a capacity of 80,000,000 cubic feet daily at 450 pounds; and the same company's old Plant No. 3 rebuilt to handle between 50,000,000 and 80,000,000 cubic feet at the same pressure. Prominent in Kettleman Hills gasoline operations is the extensive construction of compressor plants. This work alone is reported to have cost more than $1,000,000.

Viewing these developments in retrospect, one is impressed with the fact that so gradual and conservative have they been that it is with satisfaction that the realization comes that the Pacific Coast natural gasoline industry is on the up-grade and keeping pace with field developments.

Belridge Plant No. 4 at North Belridge

C. L. PARKHILL
Parkhill-Wade, Los Angeles, California

IN MY opinion, the thing of greatest value in the presentation of a paper of this kind is not the reading, or delivery of the paper itself, rather, a paper of this nature is valuable to all of us—the speaker, included—only in direct proportion to the amount of discussion its reading encourages.

It all too frequently occurs that the author has treated too lightly some phase of the subject under discussion that the members of the audience consider important. The fact that the author did not elaborate the point is not due to unwillingness, but rather to his psychological state at the time. The thing discussed is thoroughly familiar to him. Its problems and obstacles have been met and overcome—taken in stride, so to speak, and, as a result of this familiarity it is only natural that he may have a tendency to treat too lightly some point that may constitute a genuine problem of the moment to someone else.

I preface this paper with these remarks for two very concrete reasons. The first is my desire to make this paper prove valuable to you. The second is due to the fact that the cycle employed at Belridge Plant No. 4 is familiar to all of us and therefore presents much material that would be repetitive. However, the plant does incorporate several features of note, and I am therefore going to confine my remarks to these features rather than to an elaborate discussion of the cycle itself. I trust the material presented will encourage a lively discussion.

Belridge Plant No. 4 was built as a turn-key job and the completed plant turned over on April 1, 1937. The plant is designed for a capacity of 80 million cubic feet of natural gas per 24 hours at 450 pounds gauge. The still is designed for a capacity of 75,000 gallons per day and the stabilizer will make a product having a Reid vapor pressure of from 20 to 27 pounds.

As to the general features of the plant, engineers who have visited it since completion have paid us gracious compliment by stating that it represents the latest and most modern absorption plant yet seen in California, and we have been particularly pleased by their comments regarding the quality of workmanship and the neat, orderly battleship-like appearance of the plant as a whole.

One of the major goals sought in the design of the plant was compactness. This feature is best illustrated by Figure 1, a bird's-eye view taken from the top of the cooling tower, showing the placement of the various vessels and equipment condensed into a comparatively small yard area with the layout

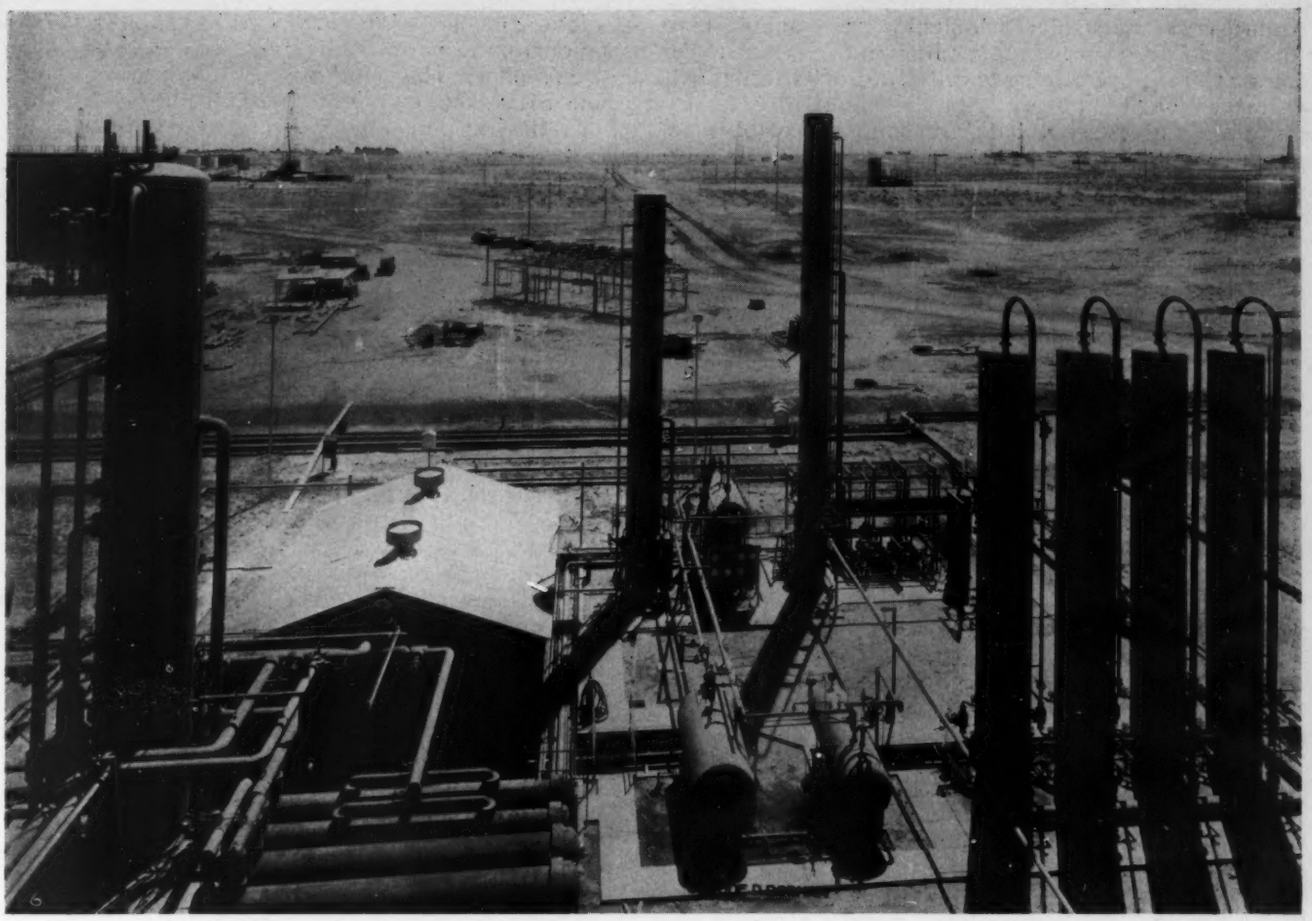


FIGURE 1
Showing compact arrangement of equipment in Belridge Plant No. 4

arranged to eliminate crowding. The value of compactness lies in the fact that all of the plant units are easily accessible and the work of the operators is greatly simplified.

In line with modern practice, control of the plant is almost entirely automatic. The lean-oil circulation rate is manually set and the rest of the oil circuit controlled by pilot operated liquid level controls. The controls for the stabilizer are grouped on a single instrument panel which is located almost in the center of the plant yard. The instrument panel contains feed and reflux rate recorder controllers, a base temperature recorder controller, a column pressure recorder controller, a top plate temperature recorder and a finished gasoline vapor pressure recorder.

The towers are all of welded construction conforming to the A.P.I.-A.S.M.E. Code for Unfired Pressure Vessels. Each of the towers rests on splayed concrete foundations having ample spread to make them stable under earthquake conditions, resulting in a yard free from guy wires.

In order to combat the corrosive action of soil on plant piping, as well as to improve maintenance conditions, all piping is either run overhead, above ground supported on saddles, or below the surface in concrete trenches. Refineries have employed this design to a degree for the simplification of tracing lines and repairing leaks, but its use at Belridge is the most complete application of the method to an absorption plant in this territory.

The cooling tower arrangement constitutes an interesting feature, a development by my associate, Henry N. Wade. The tower is divided and partitioned into two sections or "ends," each having its own water circuit. In the "hot" end of the tower, where the heat load dissipated is at high temperature gradient, the tower atmosphere assumes a high wet bulb temperature due to the evaporation of cooling water. In the "cold" end, where the gradient is smaller, the heat is dissipated more through sensible heat rise than through evaporation of the cooling water. Under this arrangement, the wet bulb temperature of the "cold" end is not as high as that of the "hot" end allowing a closer approach to the atmospheric wet bulb than would be the case if the total amount of heat were dissipated in a non-partitioned tower.

The water pumps serving the "hot" and "cold" ends are installed in a pump house separate from the building housing the lean and fat oil pumps. The installation consists of an operating and a stand-by unit each composed of a 67-horsepower turbine direct connected to an 8-inch water pump feeding the "cold" end at the rate of 2500 gallons per minute and a 6-inch water pump with a capacity of 1100 gallons per minute feeding the "hot" end of the tower.

Wet gas from the field is cooled through an inlet scrubber to remove entrained crude oil, water mist and condensate. From the scrubber, the gas denuded of all entrained liquids is proportioned by differential indicators to a bank of 4 absorption towers, each designed for a working pressure of 500 pounds per

square inch. Each absorber contains 16 bubble cap plates and an outlet scrubber built integral with the top of the tower to remove all traces of absorber oil entrained during absorption. This method of handling the outlet scrubbers is an economy feature that results not only in saving valves and piping, but in conservation of plant yard space otherwise used by additional vessels.

A two-stage venting system is employed to relieve the fat oil stream from excess fixed gases. In the initial stage, the fat oil coming from the absorbers is taken into a high-pressure vent tank and held at approximately 200 pounds. This reduced pressure releases approximately 50 percent of the fixed gases in the fat oil and the vapors so released are vented to plant fuel.

In the second stage, the pressure is further reduced to approximately 40 pounds in the low pressure vent tank. The vapors from this tank are taken to the fractionating reabsorber where the desirable gasoline fractions are extracted. The reabsorber contains 16 bubble cap absorbing plates and 8 bubble cap fractionating plates and is equipped with an external vertical type reboiler.

Fat oil from the reabsorber is pumped to joint the main fat oil stream before entering shell and tube exchangers and the preheaters. The still is designed with 10 stripping and 8 fractionating plates, one dewatering plate and dehydrator leg, a feed flash plate and a reheater take-off plate with external reheater. The shell has sufficient capacity in the base to eliminate the need for a separate surge tank.

The overhead vapors from the still are carried to the gasoline condenser and the condensate delivered to a horizontal gasoline dewatering tank mounted at sufficient height to provide suction for the stabilizer feed and still reflux pumps. The stabilizer carries 30 plates and is designed for a working pressure of 225 pounds. Its flow is described in detail in Mr. Wilcox's paper which follows.

The oil sets are turbine drive, the main lean oil pumps having capacity of 375 gallons per minute and the reabsorber lean oil pump 65 gallons per minute. The main fat oil circulation rate is 440 gallons per minute and the reabsorber fat oil rate 80 gallons per minute. Details of these pumping units are illustrated in Figure 2.

Dry gas after leaving the absorption plants is dehydrated through a calcium chloride brine unit similar to that designed and patented by Henry N. Wade. Water vapor is removed by passing the gas through bubble towers where it is intimately contacted with a concentrated calcium chloride brine which absorbs the water vapor. Brine concentration is maintained by boiling off the absorbed water.

Modernization designed to bring the operation of Plant No. 3, built in 1930, up to that of Plant No. 4 as described was completed recently. This work included complete replacement of many of the units including a new cooling tower and open sections, new still, reabsorber, a high-pressure absorber, preheaters inlet scrubber, the rebuilding of the outlet scrubber, and a complete revamping of the stabilizing unit.

Plant No. 4 is separated from Plant No. 3, by approximately 500 feet, giving the operating advantages of a single unit with the safety features of separation. The boiler plant is approximately 350 feet from either of the absorption units and the storage is separated from both by about 30 yards.

The lighting in both plants is notable in that they are practically 100 percent flooded, with individual lighting at control points. As a result Belridge is a landmark from the San Francisco-Los Angeles airline.

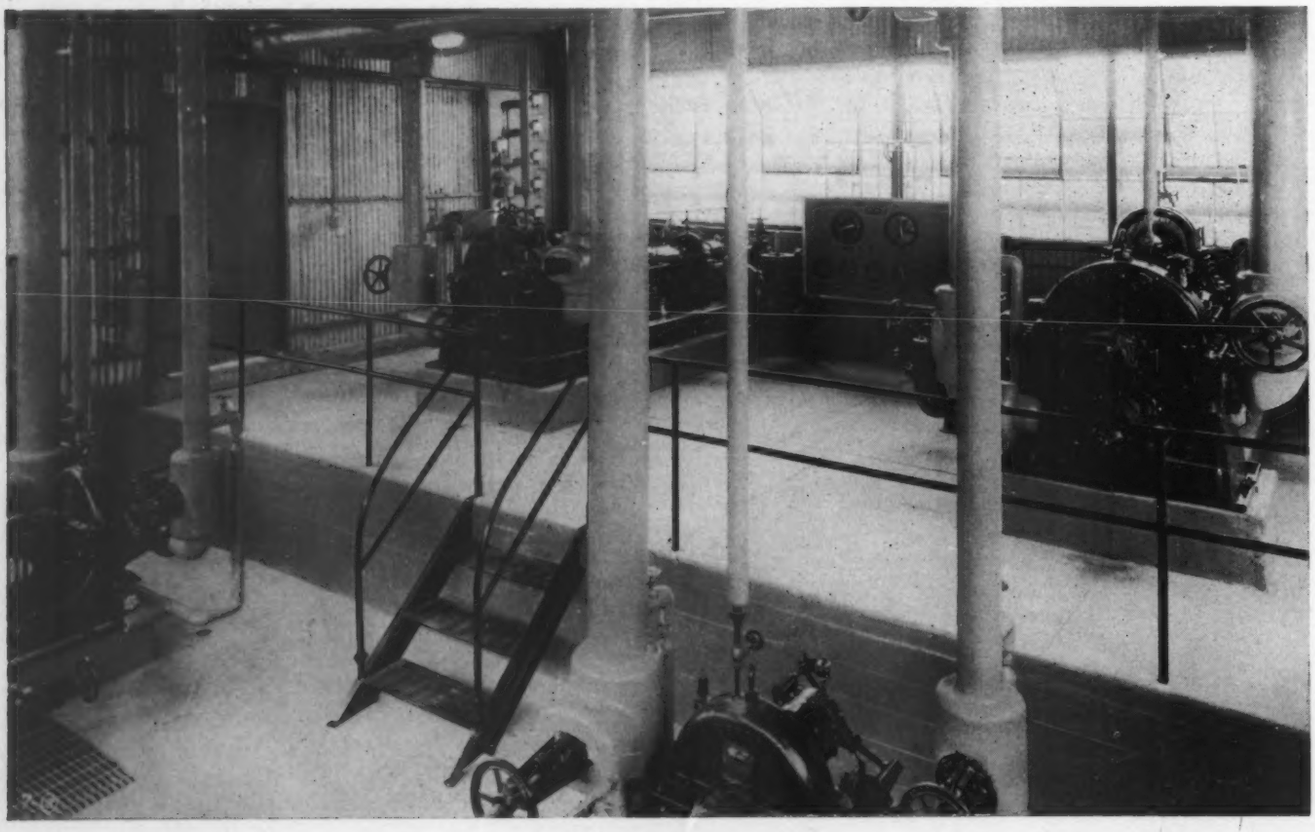


FIGURE 2
Pump room at Belridge Plant No. 4

The Wilmington Absorption Plant of the General Petroleum Corporation

M. E. GARRISON
General Petroleum Corporation of California

THE Wilmington Absorption Plant was built early in 1937 and has already been enlarged several times to keep pace with the rapid development of the field. The distillation unit was so arranged that it could be enlarged in steps to handle a maximum of 560 gallons of lean oil per minute and to handle a maximum of 75,000 gallons of raw gasoline per day. Gas collection, processing, and distribution differ in many respects from other California field practices. This paper will describe the plant and discuss some of the differences from the average practice.

FIELD CONDITIONS

The discovery well, Terminal No. 1 of General Petroleum Corporation came in on December 6, 1936. This well is located just west of the north end of the Badger Avenue bridge at the end of Ford Avenue in Wilmington. This well produced 1389 barrels of oil and 328 million cubic feet of gas through a 1½-inch flow bean. The oil was 19.6 degrees A.P.I. gravity and the gasoline content of the gas was 2.48 gallons of 20-pound Reid vapor pressure gasoline per million cubic feet. The casing pressure was 380 pounds per square inch and the tubing pressure was 240 pounds per square inch. The oil and gas produced was quite warm, approximately 126° F. at the tubing. The gasoline content of the oil was found to be considerably lower than other California crudes of like gravity.

After observing similar data from several wells and from experimentation with gas trap pressures, it was found that where the gas trap pressures were lowered to 8 to 10 pounds per square inch the receiving tank vapors were found to be so small in quantity that a gas collection system was not necessary or economical. Such trap pressures however, required elevating the trap at a location close to the well receiving tank for gravity flow of the oil.

This pressure permits choosing plant intake pressures of from 2 to 3 pounds with a pressure drop of from 6 to 7 pounds between the well and the plant. This reduces the size and cost of the gathering lines as compared to the usual plant intake pressure of 10 inches mercury vacuum.

A preliminary estimate of the quantity of gas to be produced was based on an average daily production of 200 million cubic feet of gas per well, a figure which has been substantiated fairly well.

LOCATION OF THE PLANT

A four-acre site was selected near the Ford assembly plant. The location has several advantages, primarily that it is close to the center of the field and permits the economical use of ocean water for cooling purposes. Its chief disadvantage is the low bearing load which can be sustained by the soil. All of this land is artificial in the sense that it was formed in the process of dredging the channels and piling up the debris. To provide good foundations for equipment a large number of piles had to be driven.

The site was covered with approximately 18 inches of decomposed granite earth from the Palos Verdes Hills to provide some surface drainage and to diminish the mud troubles in wet weather.

PLANT LAYOUT

See Figure 1. This figure shows the general layout of the plant: Figure No. 2 shows the flow sheet of the distillation equipment.

The location of equipment was governed by Los Angeles City and County Ordinance requirements and by company safe practice. For example, gasoline storage tanks and gasoline loading racks must be at least 30 feet from the property lines; boilers compressor plants, etc. must be at least 20 feet from such lines; the compressor station must be at least 125 feet from any drilling rig and preferably at least 100 feet from the distillation unit and the gasoline storage tank area. The boilers should be preferably on the windward side of the plant with respect to the prevailing winds, and at least 100 feet from the distillation unit equipment, and on the opposite side of the plant from the gasoline storage tanks. The gasoline loading rack should be located at least 100 feet from any of the plant operating areas. All of these considerations have been met.

While the need of some of these clearances is subject to argument it is generally conceded that distance between hazards increases safety by some function of the distance.

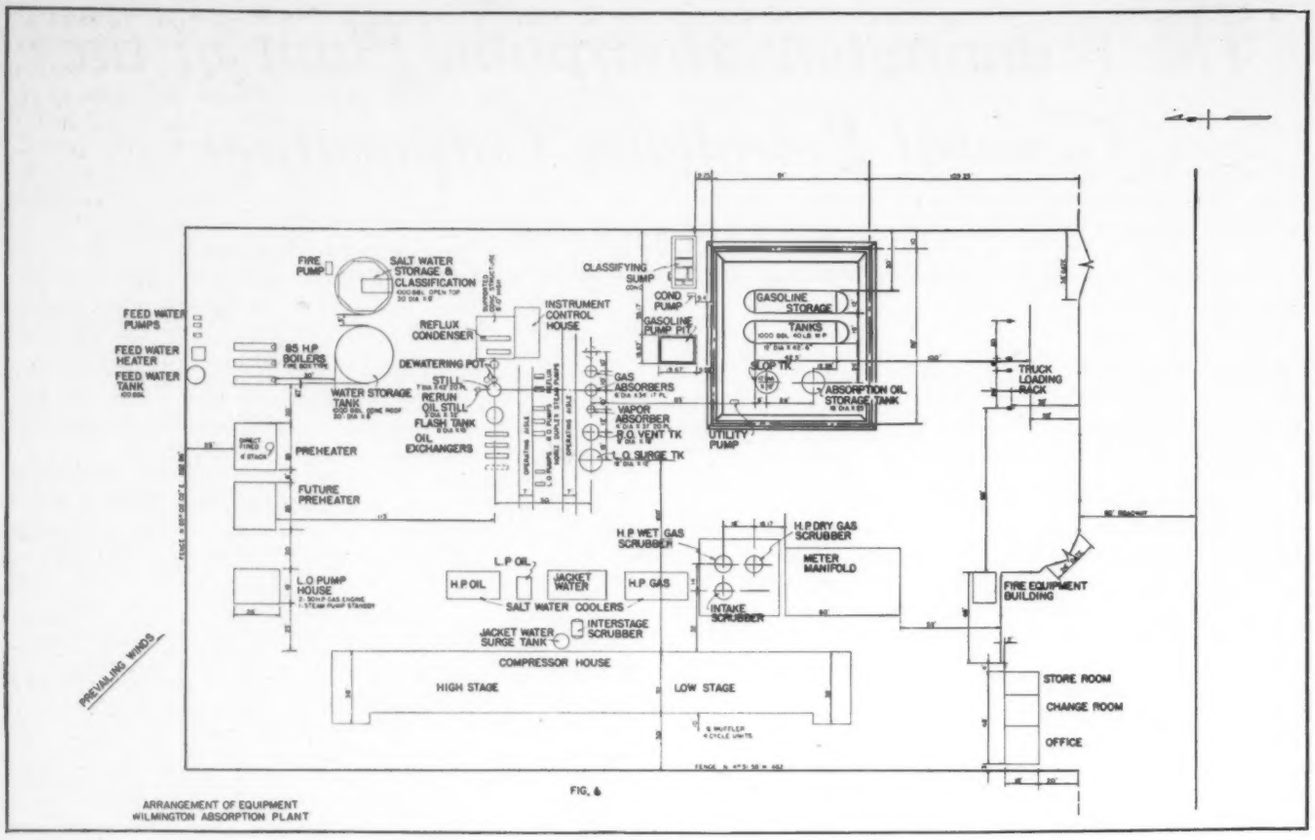
FOUNDATIONS

A test piling was driven 50 feet before it was adjudged satisfactory and this length was specified for all piles.

A loading of 20 tons per pile was used for all stationery equipment and a loading of 20 tons per pile was used at first and later decreased to 15 tons per pile for all compressor foundations. The loading was decreased in order to diminish vibration.

Six vertical piles were driven under each horizontal gas engine-driven compressor unit with large concrete bases capping the piles. The latest compressors installed were considerably larger than the horizontal units and are of the vertical type and have in addition to the 50-foot vertical piles a row of 12-inch concrete-filled steel brace piling on each side on 35-foot centers. The brace piles were driven at an angle of approximately 20 degrees from the vertical and slope outward from the center line of the unit.

Where piling was not used under foundations



ARRANGEMENT OF EQUIPMENT
WILMINGTON ABSORPTION PLANT

FIG. 6

FIGURE 1

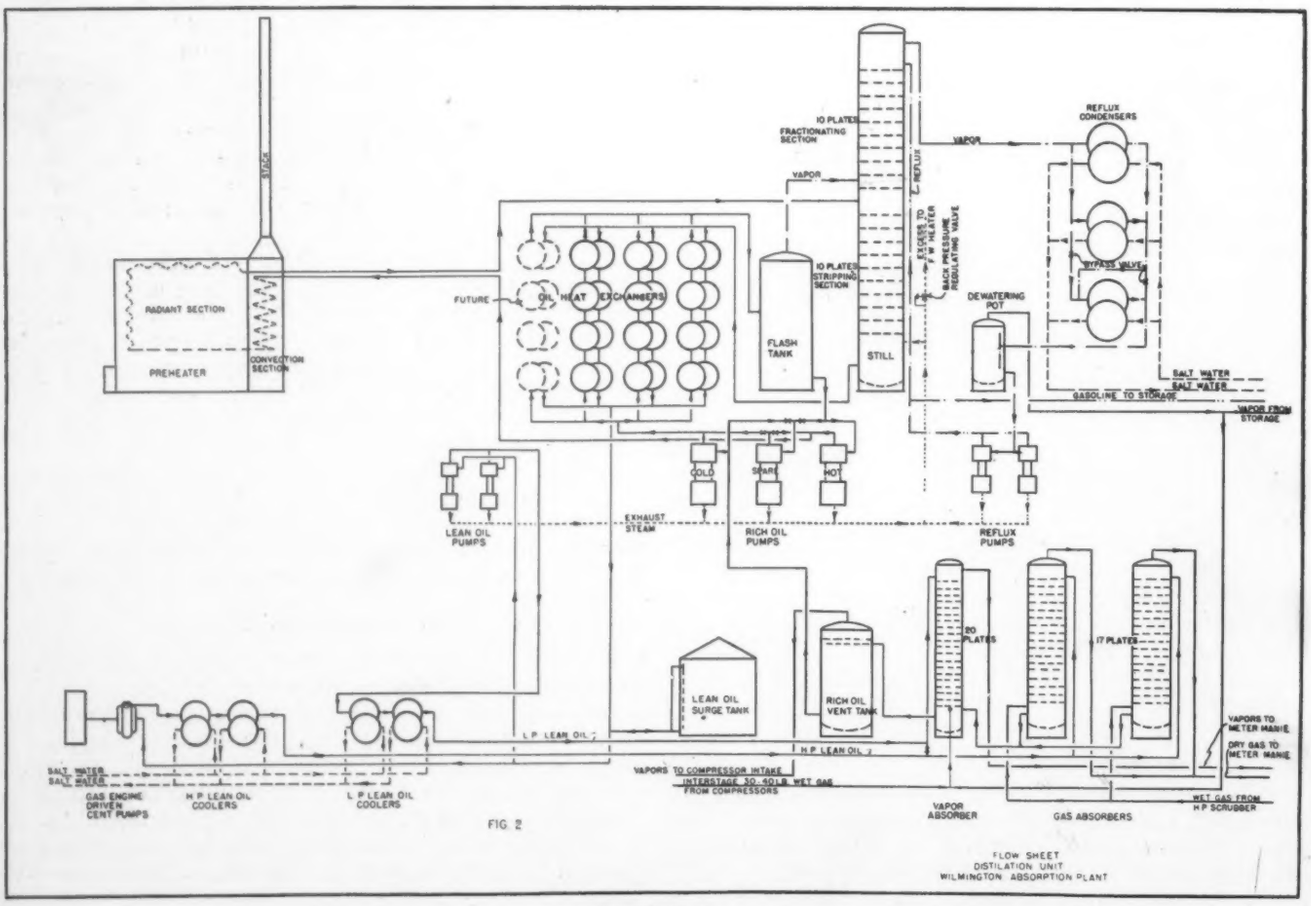


FIG. 2

FLOW SHEET
DISTILLATION UNIT
WILMINGTON ABSORPTION PLANT

FIGURE 2

the soil bearing pressure was limited to 500 pounds per square foot including the weight of the concrete. This applied to pipe supports as well as to structures.

ABSORPTION PRESSURE

Absorption at 150 pounds per square inch was selected over 35 to 40 pounds for several reasons; first, dry gas could be delivered to the gas company without further compression and at a premium over 35 pounds per square inch; second, it permitted the use of considerable equipment available at the Santa Fe Springs absorption plant, particularly a large quantity of piping materials; third, it increased the recovery of gasoline from the wet gas; fourth, and due to reduced oil circulation rate it decreased the boiler capacity required; fifth, it increased the flexibility for expanding the distillation unit and for distributing the dry gas. On the other hand the 150-pound absorption method required considerably greater compressor station installation expense to keep up with the increases in the gas volumes. However, this equipment has the least deterioration and the greatest salvage value.

Two-stage compression was required between the 2-pound intake and the 150-pound discharge pressures. In order to reuse the piping from Santa Fe Springs most economically, all the low-stage compressor units were placed at the one end and all of the high-stage compressor units at the other end of the compressor plant. The auxiliary units were placed between the low- and high-stage compressor units. This necessitated some special controls for balancing the load when a high-stage compressor unit is shut down.

FLOW SHEET

See Figure 2. The flow sheet incorporates several features which are not new in themselves but which have not been grouped together in this manner before.

The use of a flash tank at the end of the exchangers on the rich oil stream is of interest. The rich oil is pumped from the rich oil vent tank through the heat exchangers and into the flash tank. The oil entering the flash tank is around 275-285° F. Approximately 80 to 85 percent of the absorbed gasoline in the rich oil flashes off at this point and enters the main still one plate above the feed plate. The partially stripped oil is again pumped from the flash tank through a direct-fired heater and to the still.

A direct fired heater of our own design, patterned after refinery practice, was built for preheating the rich oil to 350-400° F. It consists of a convection section about 80 percent to the radiant section and 20 percent to the convection section. Skin temperatures on the tube walls will vary from 400 to 500° F. At a 200-gallon-per-minute rate through the heater the pressure drop is around 26 pounds per square inch.

The use of the flash tank reduces the heat load required in the heater and reduces the volume pumped through the heater, thus saving in fuel and in pumping costs.

The main still is 7 feet in diameter and has 10 stripping plates and 10 fractionating plates. The fractionating section is rated to handle 75,000 gallons of gasoline production per day with a 2-to-1 reflux ratio. The stripping section will handle a maximum of 560 gallons of oil per minute.

Exhaust steam from duplex pumps is used for agitation steam in the still and for boiler feed water heat. The pumps used for this purpose are the reflux pumps, the low-pressure lean oil pumps, and the rich oil pumps. A back pressure regulator is used in the exhaust steam line, discharging any excess steam to the feed water heater. By using the curves shown in Figure 3 as a basis, the temperature of the rich oil leaving the heater may be adjusted to prevent blowing any unnecessary steam to the air. As the temperature of the rich oil from the heater rises, the amount of agitation steam diminishes. The amounts of agitation steam required for different still bottom temperatures are shown for three different still operating pressures. It may be noted that the agitation steam requirements are considerably less for the lower pressure. As the temperature of the oil in the still is raised the amount of reflux required increases to make a given specification gasoline.

Raw boiler feed water makeup is reduced by returning the condensate from the reflux dewatering tank to the feed water heater.

The results of these ideas is a flexible and an economical operating plant. For example, when circulating lean oil at a 250 gallon per minute rate and maintaining a rich oil temperature of 355° F at the heater outlet with a plant output of 33,000 gallons of gasoline per day, the steam load is such that it can be handled by one 85-horsepower firebox boiler.

Rich oil from the 150-pound absorbers is vented to 30 pounds in the base of the vapor absorber and again to 5-8 pounds in the rich oil vent tank. The vapors from the rich oil vent tank pass to the compressor suction and are the only vapors in the plant that are recompressed. Vapors from the gasoline dewatering pot and from the gasoline storage tanks go to the base of the vapor absorber. The low-stage compressor discharge is also connected to the base of the vapor absorber for emergency loading.

The vapor absorber is 4 feet in diameter and has 20 plates on 18-inch spacing, and can handle approximately 2,000 M cubic feet of gas.

Liquid level control consists of pilot level controllers operating normally closed type motor valves. All motor valves are connected to one pilot air supply line so that all can be closed from a remote point in case of fire or other emergency. Electrically operated high level alarms are connected to a signal light on the main control board and also operate a common plant horn.

The lean oil pumps for the high pressure absorbers are gas engine driven. A low pressure lean oil pumping circuit was also installed. This arrangement provides an economical method for handling the lean oil as the load upon the plant varies.

OIL CONDITIONING

An auxiliary vacuum still is operated periodically for reconditioning the absorption oil. The bottoms from this still are recirculated through a separate heating coil in the direct-fired heater. A steam jet type ejector is used to hold 20 inches of mercury vacuum in the equipment. The reconditioned oil is returned to storage. There is no evidence of oil breakdown in the main absorption oil system due to heating and the need for reconditioning is due only to oil contamination from the gas.

Oil conditioning methods, even in direct-fired

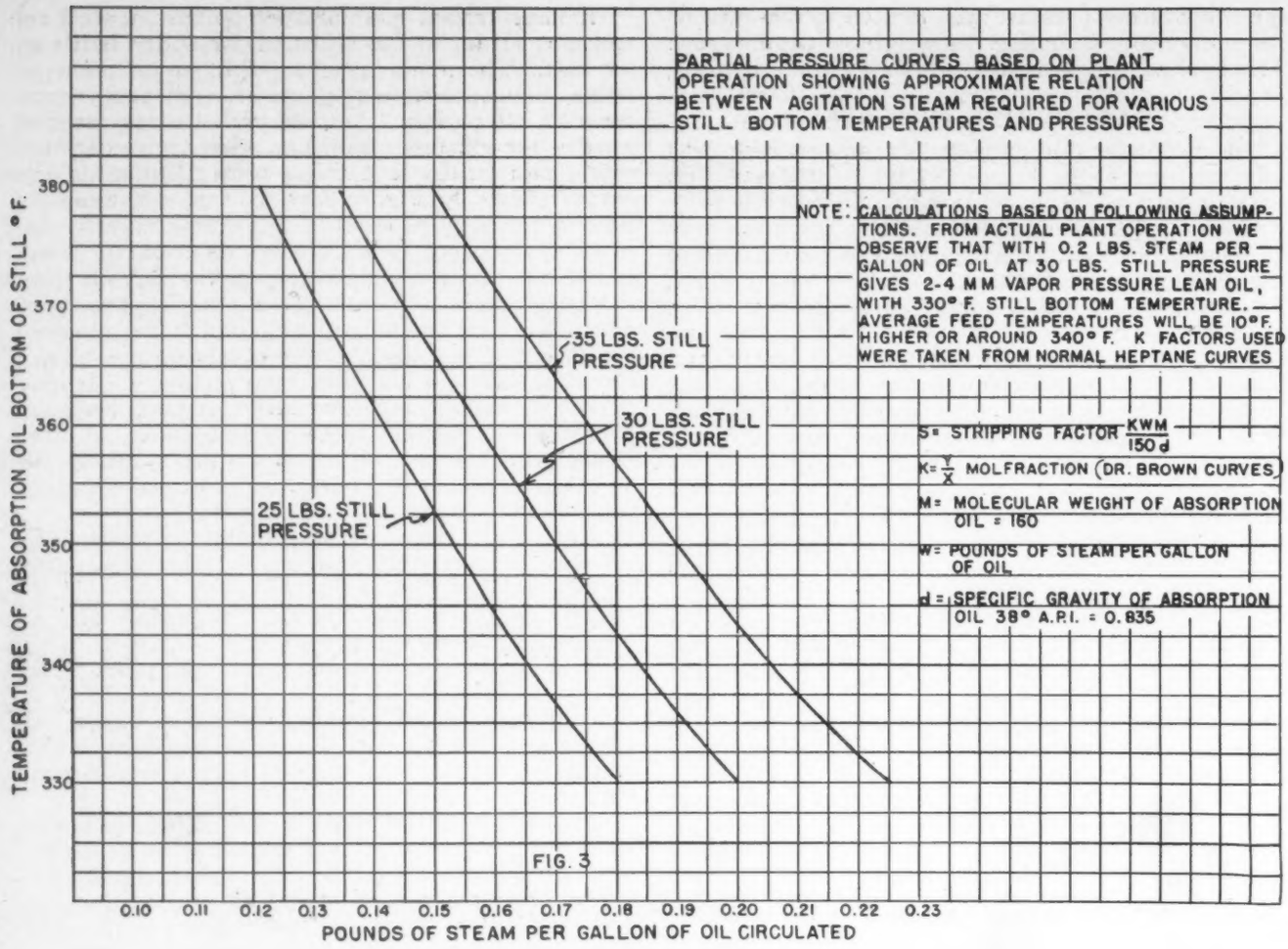

PARTIAL PRESSURE CURVES BASED ON PLANT OPERATION SHOWING APPROXIMATE RELATION BETWEEN AGITATION STEAM REQUIRED FOR VARIOUS STILL BOTTOM TEMPERATURES AND PRESSURES
NOTE: CALCULATIONS BASED ON FOLLOWING ASSUMPTIONS. FROM ACTUAL PLANT OPERATION WE OBSERVE THAT WITH 0.2 LBS. STEAM PER GALLON OF OIL AT 30 LBS. STILL PRESSURE GIVES 2-4 M M VAPOR PRESSURE LEAN OIL, WITH 330° F. STILL BOTTOM TEMPERTURE. AVERAGE FEED TEMPERATURES WILL BE 10°F. HIGHER OR AROUND 340° F. K FACTORS USED WERE TAKEN FROM NORMAL HEPTANE CURVES
35 LBS. STILL PRESSURE
30 LBS. STILL PRESSURE
25 LBS. STILL PRESSURE
S= STRIPPING FACTOR KWM/150d
K= Y/X MOLFRACTION (DR. BROWN CURVES)
M= MOLECULAR WEIGHT OF ABSORPTION OIL = 150
W= POUNDS OF STEAM PER GALLON OF OIL
d = SPECIFIC GRAVITY OF ABSORPTION OIL 38° A.P.I. = 0.835
FIG. 3
TEMPERATURE OF ABSORPTION OIL BOTTOM OF STILL °F.
380
370
360
350
340
330
0.10 0.11 0.12 0.13 0.14 0.15 0.16 0.17 0.18 0.19 0.20 0.21 0.22 0.23
POUNDS OF STEAM PER GALLON OF OIL CIRCULATED

FIGURE 3

heaters is not new. It was used in the San Joaquin Valley oil fields as early as 1921, particularly where emulsification gave trouble with the use of the compartively heavier gravity absorption oils.

COMPRESSOR STATION

Several of the compressors moved from the Santa Fe Springs plant were two-cycle units. These were rebuilt into the overhead exhaust type. Exhaust pipes within the compressor building are insulated with a high temperature asbestos insulation protected by a thin sheet-metal cover. This makes a cooler building than air jacketing. Above the building roof a concentric galvanized iron jacket was installed to the top of the muffler. This was open through the roof of the building and to the air above, serving as an air jacket and a chimney to carry off hot air from the compressor building. This jacket hides the muffler and can be painted, whereas the paint does not remain upon the mufflers for any great length of time. This adds to the plant appearance.

SEA WATER COOLING SYSTEM

Average wet bulb temperatures in this area are such that from 80 to 85° F. is about the lowest practical temperature that could be expected from a cooling tower. Ocean water temperatures will average around 65° F. and never exceed 75° F. Electric current for pumping is comparatively cheap and purchased water costs are comparatively high. These facts led to the use of the ocean water for cooling.

A pumping plant was installed on a wharf in the Long Beach channel east of the Ford Plant slip, with an 18-inch steel pipe line to the absorption plant. A gravity return line of vitrified tile was used. Two deep well pumps driven by 75-horsepower totally enclosed vertical shaft electric motors were installed for pumping salt water. With one pump operating on the line 2700 gallons of water per minute are pumped; with both pumps operating 5000 gallons of water per minute are pumped.

This necessitated the installation of a closed jacket water system with pure water for compressor engine jacket cooling.

Several precautions against sea water corrosion were taken. Air eliminators of the float type were installed to reduce the accumulation of air at the high points in the system. These air pockets are known to accelerate corrosion. Chlorine injection was provided to kill algae and organisms. Brass tubes, either Admiralty or Yorcalbra metal were used, but galvanic action was found to be undesirably rapid between these tubes and the cast iron cases or bodies. To protect the iron, the channels and covers were painted inside with two coats of a rubber insulating paint. Also, ¾-inch zinc plugs 5 inches long were installed in the channels to absorb the electrolytic energy. These plugs disintegrate in approximately two months operation. If this method does not satisfactorily take care of this problem the Kirkaldy method, or counter electrolytic method, will be tried.

Barnacles have thus far been found only in the

first 200 feet or so of the pipe lines from the salt water pumps. Separate lines were installed from each pump for the first 300 feet from the pump, then connected into a common main. Fresh water is connected into each of these lines so that they may be filled with fresh water when not in operation. It has been found that fresh water kills the barnacles. Either line may be cleaned without interrupting the flow of water to the plant.

Double screens were installed around the salt water pumps. The outer of these screens may be raised for cleaning. Screens were also installed at the ends of the individual pipe line from each pump and at the entrance to each cooler. Considerable thought should be given to the design of these screens because of frequent cleaning without interruption to the flow of water and at short notice.

A 1000-barrel skimming tank 8 feet high and 30 feet in diameter was placed in the salt water return system. The water entering this tank was carried through a weir box placed across the top of the tank from the edge to the center of the tank. The water discharges vertically from the weir box into the center of the tank. A vertical wood baffle extending from about 18 inches from the bottom of the tank to within about 6 inches of the top of the tank and placed approximately 8 inches in from the shell of the tank was installed around the inside of the tank. On the upper edge of this baffle a skimming trough was installed so that any oil separating out in the quiet space between the baffle and the wall of the tank could be skimmed off. The salt water is removed through two 12-inch pipe connections located up five feet on the shell of the tank. These connect into a 24-inch diameter vertical standpipe which in turn connects to a 24-inch diameter vitrified gravity drain line back to the harbor.

STORAGE TANKS

Two 1000-barrel welded gasoline storage tanks suitable for a working pressure of 40 pounds per square inch were installed, each 12 feet in diameter and 42 feet, 6 inches long, with hemispherical heads. Each tank has two outside ring girders which carry the load. The tanks are installed in a horizontal position. One ring girder is bolted rigidly to the foundation and the other rests upon rollers to permit movement with temperature changes.

PIPE LINES

Wherever possible all pipe lines have been installed above ground. Lines have been arranged above ground to run parallel with each group of equipment. The crossover lines between groups have been buried. Soil corrosion is unusually bad upon pipe lines buried in this area. Plant piping is much easier maintained where it is installed above ground.

The Rancho Gasoline Plant

FRANK W. WILCOX
Parkhill-Wade, Los Angeles, California

THE Rancho Gasoline Plant which was designed and erected during the past summer for the Rancho Gasoline Corporation by Parkhill-Wade is located on the Reserve Lease in Kern County, is approximately two miles east of Highway "99" and about five miles north of Grapevine.

This plant is designed to handle a maximum of 20,000,000 cubic feet of natural gas per day at 450 pounds working pressure, with a lean oil circulation rate of 125 gallons per minute. The distillation and stabilization capacity of the plant is 15,000 gallons per day of 26 pounds Reid finished gasoline.

When Mr. Parkhill gave the highlights of the Belridge Plant No. 4 (above), he greatly simplified my task because the Rancho Plant like Belridge is typical of our high-pressure design. Both employ the same cycle, the major point of difference being capacity. Like Belridge, Rancho has received much favorable comment on its compact layout, its neat, orderly appearance, and the quality of its workmanship. As will be noted from a bird's-eye view Figure 1, all lines are in trench or above ground, greatly simplifying problems of maintenance and repair as well as eliminating corrosion factors.

The plant is automatic in operation, the liquid level controls on the vessels handling the oil circuit after manual setting of the lean oil. To augment the automatic feature of the plant, as well as to make it as fool-proof as possible, alarms with audible signals are installed. These include high level on the high- and low-pressure vent tanks and on the intake scrubber; low pressure on the lean oil discharge, the plant pilot supply system and the cooling water discharge, with both high and low alarm on the boilers.

The absorption tower is a combination of three separate pieces of equipment in one shell, designed for 500 pounds working pressure. The base section of the tower contains an inlet scrubber, the central portion a 16-plate bubble cap absorber, and the top, the outlet gas scrubber. This combination has several distinct advantages, the entire gas cycle being confined to a single shell. This makes possible a substantial saving in piping cost as well as material conservation of yard space.

As is the case at Belridge, Rancho employs a two-stage venting system. Pressure is reduced in the first stage to approximately 200 pounds, thereby relieving the fat oil of approximately 50 percent of its fixed gases which are vented to plant fuel. A second stage operating at 30 pounds discards a substantial amount of usable gasoline which is processed through the reabsorber, the vent vapors from which are carried to plant fuel.

The still, condenser, gasoline dewatering tank and

FIGURE 1

Air view of Rancho Gasoline Plant.

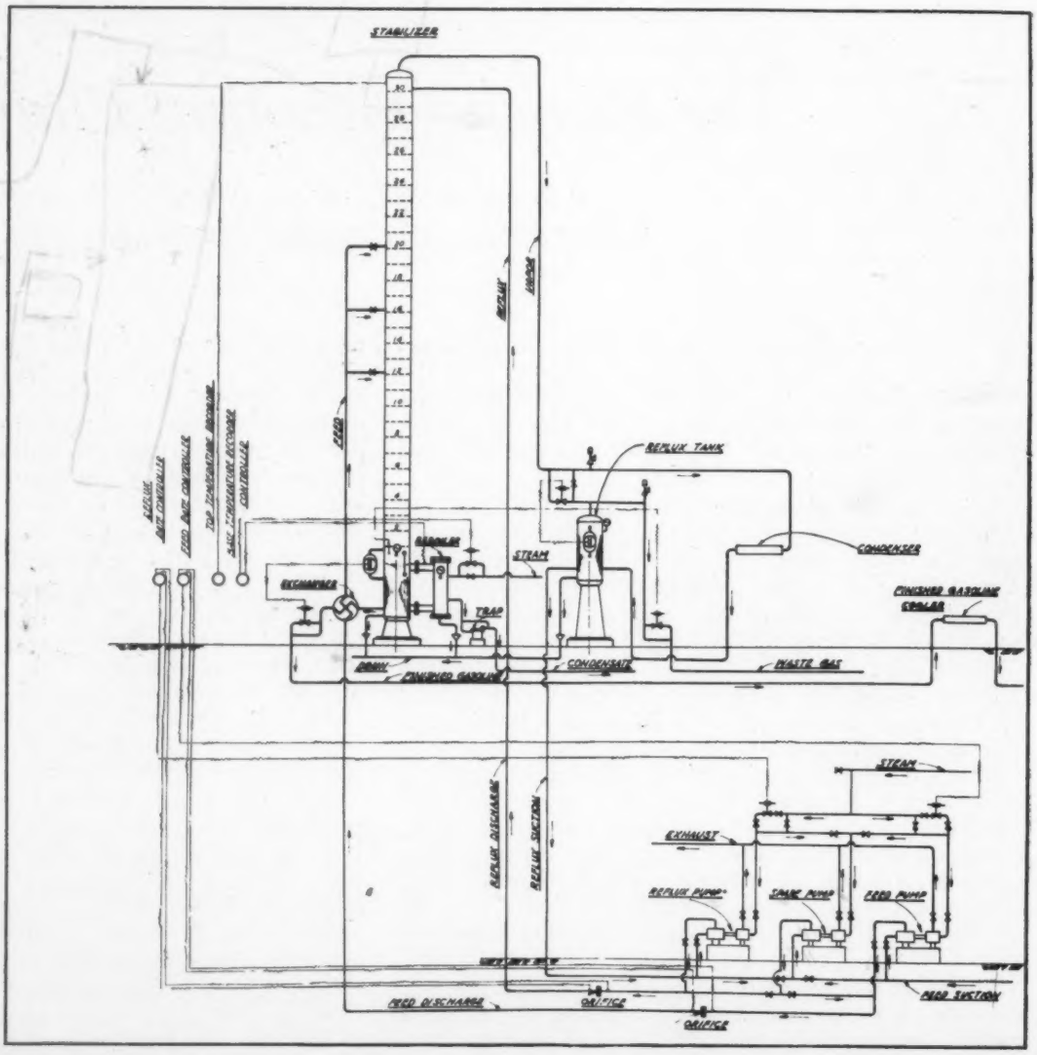


FIGURE 2

Flow Sheet of Stabilizer Unit.

reabsorber are similar in design to those at Belridge hence will require no additional comment here.

The stabilizer unit is designed for a working pressure of 275 pounds per square inch. The column contains 30 bubble cap plates on 18-inch spacing. The reboiler is an external vertical tubular type which gives excellent heat transfer rates.

The stabilizer control is a patented Parkhill-Wade cycle. This circuit is so arranged that only the amount of reflux required by the column is condensed, the excess being discarded to the stack as a warm vapor directly from the top plate of the column. The condenser by-pass valve is controlled by the liquid level in the reflux tank. Should the condenser tend to over make reflux, the condenser by-pass valve opens, reducing the pressure difference applied across the condenser so that the condensate backs up into the condenser, flooding more surface and thereby retarding the rate of condensation. The additional opening of the by-pass valve allows more vapor to pass directly from the top plate of the column through the back pressure regulator to the stack. Conversely, should the condenser tend to under make reflux, the condenser by-pass valve partially closes, increasing the pressure difference between the stabilizer top and the reflux accumulator, thereby uncovering more condenser surface. This condenser control using open cooling sections automatically compensates for atmospheric temperature variations. The circuit in detail is shown in Figure 2.

The stabilizer feed and reflux rates are controlled to maintain a constant ratio. The base temperature, top temperature and pressure are controlled and recorded. The instruments are all mounted on a single outdoor panelboard which is located immediately adjacent to the stabilizer unit for the convenience of the plant operator, as shown in Figure 3.

Boilers and storage are somewhat conventional in make and for that reason not commented on in detail.

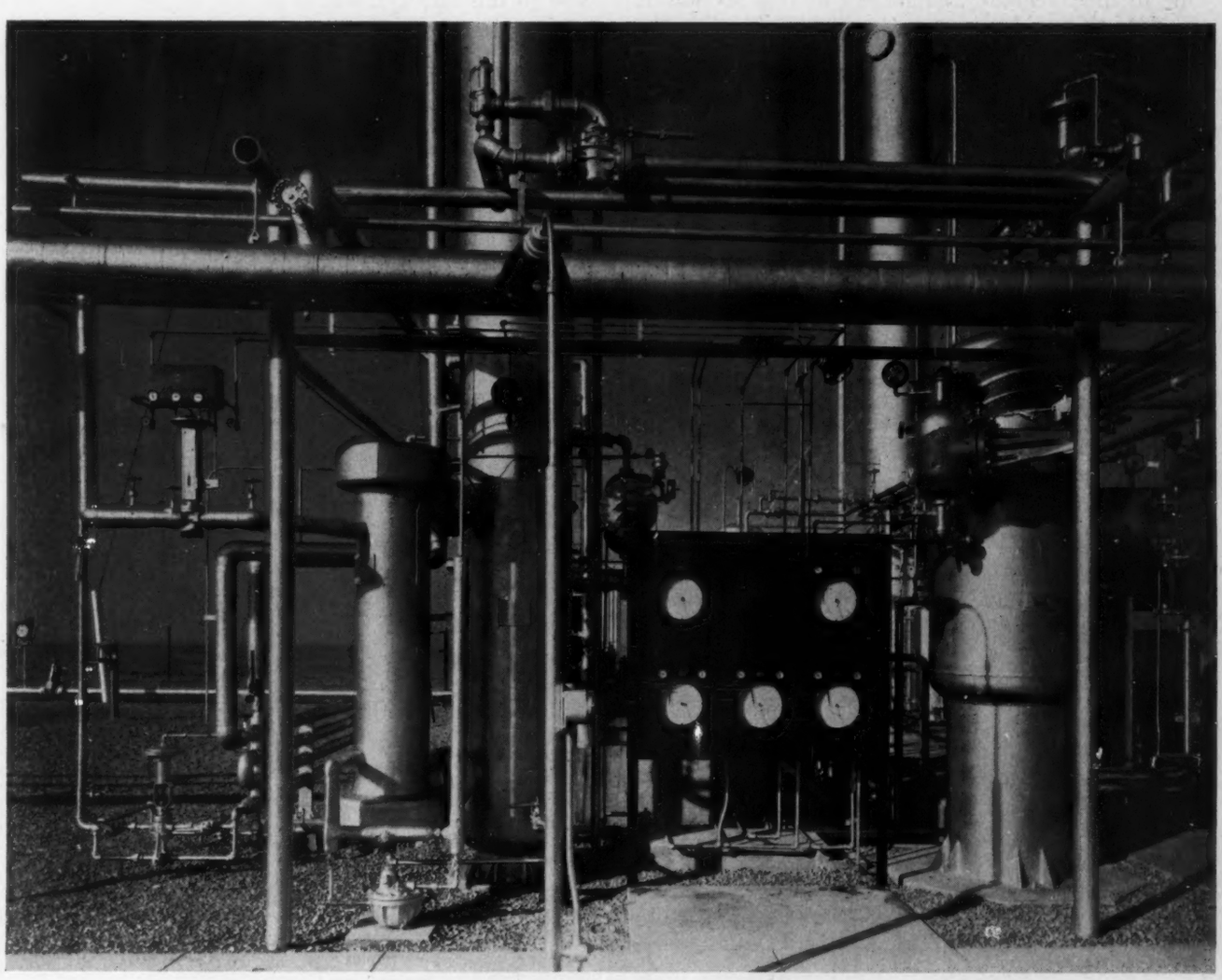


FIGURE 3

Rancho Gasoline Corporation's Gasoline Plant has control instruments mounted on an outside board.

The Texas Company Shiells Canyon Gasoline Plant

FRANK WEST
The Texas Company

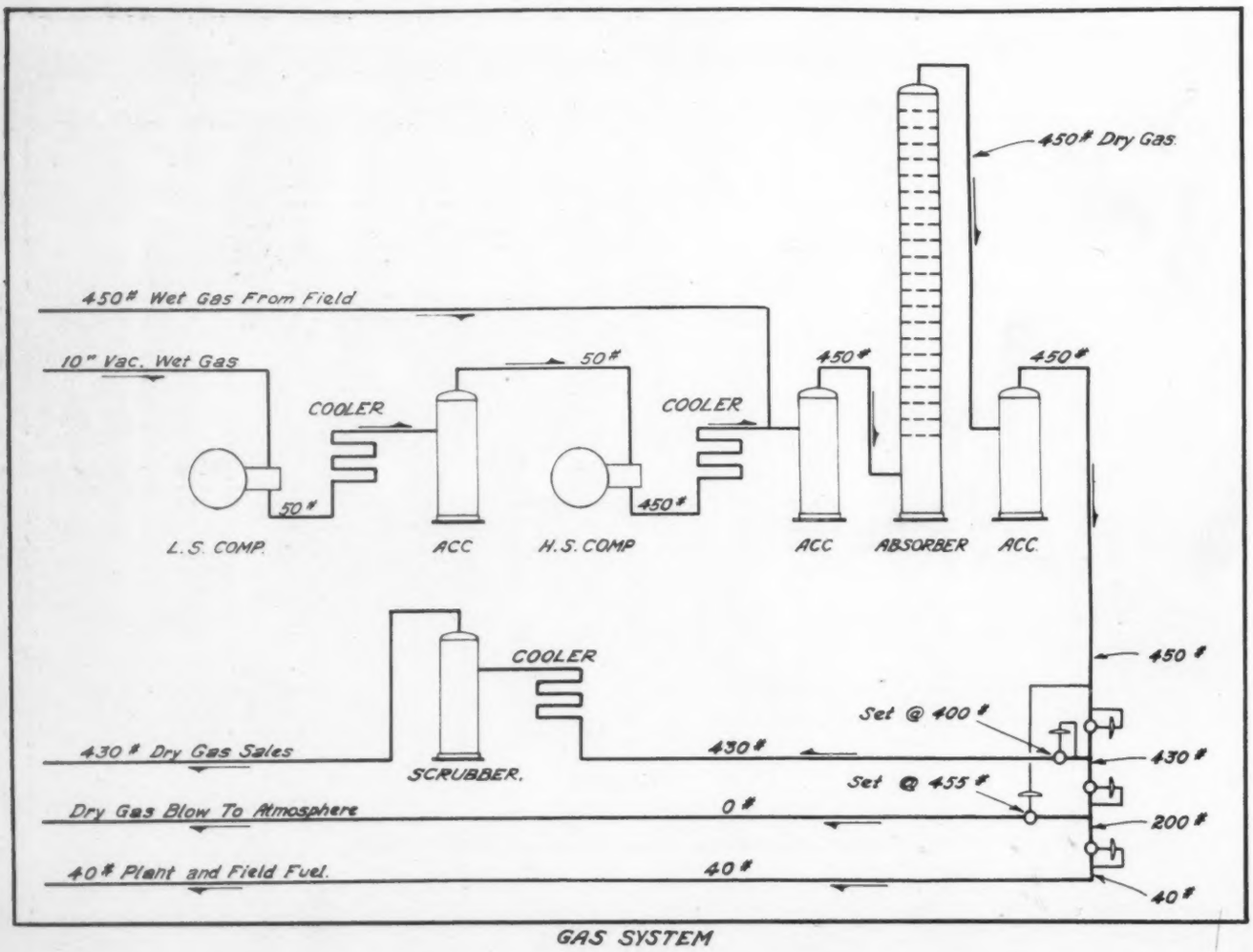
DURING March 1937, The Texas Company started construction of a new gasoline plant located at Shiells Canyon near Fillmore. The plant was completed and put into operation the last of June.

The site, containing approximately four acres, is situated a little more than a mile south of the Santa Clara River and is at an elevation of about 900 feet. Due to the irregular topography of this section and in order to avoid unnecessary excavation, the plant equipment was placed on three different elevations. The cooling towers are located on the highest level, the compressor plant on the intermediate level and the boiler plant, distillation unit and storage tanks are at the lowest elevation.

Although the plant is modern in every respect there is nothing very unusual or unique in regards to layout or design and in general is quite a conventional gasoline plant. However, there are three points of possible interest in regards to its design, each of which will be briefy described.

THE WET AND DRY GAS SYSTEM

The flow of gas from the field, through the plant and to the fuel systems is shown by Figure 1. The greater part of the wet gas received at the plant is under vacuum pressure, although some high-pressure gas is available. After being properly scrubbed and metered the vacuum gas enters the low-stage compressors, through which it is boosted to a pressure of about 50 pounds gauge and then cooled by atmospheric cooling sections. The condensate is removed in an intermediate accumulator and the



GAS SYSTEM

FIGURE 1

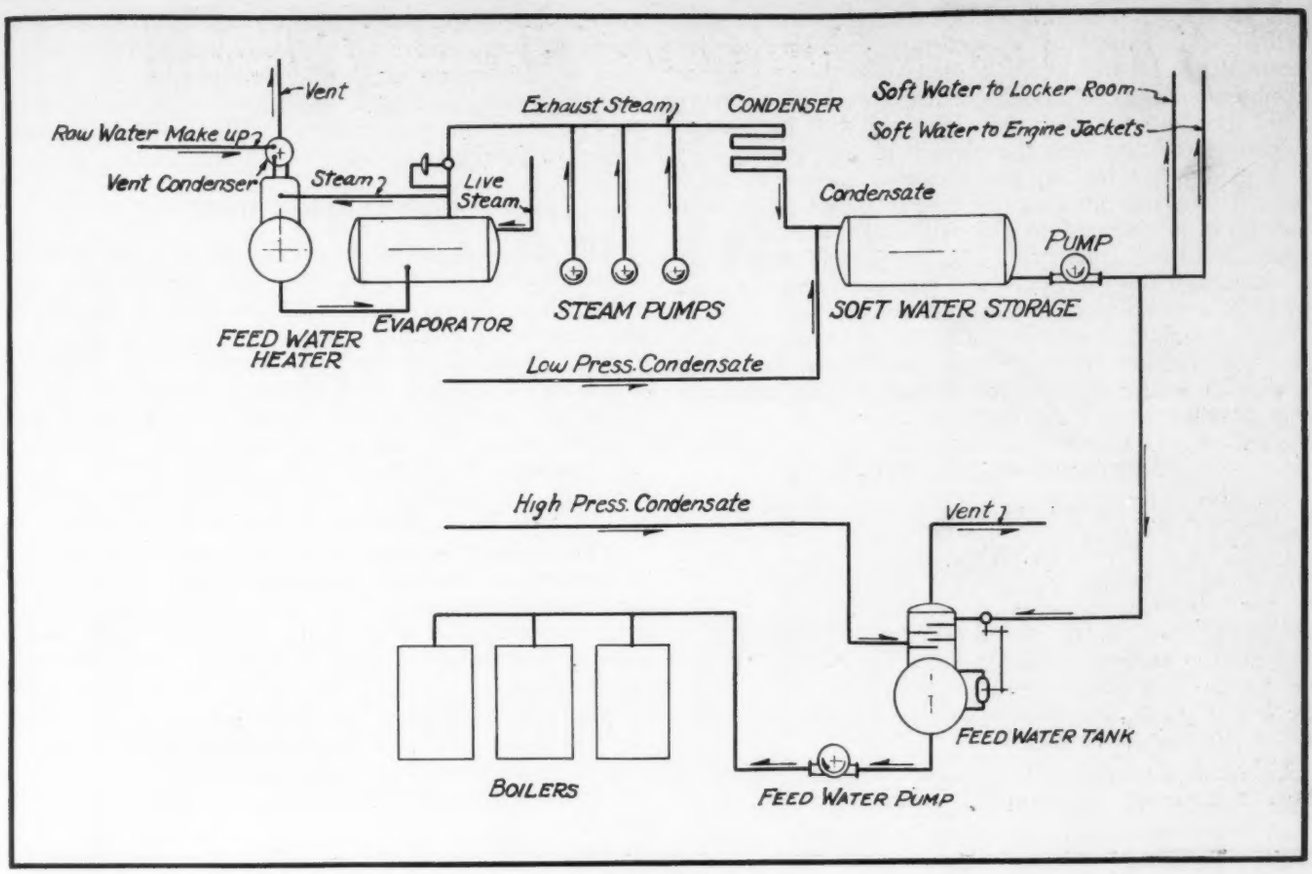


FIGURE 2
Soft Water System

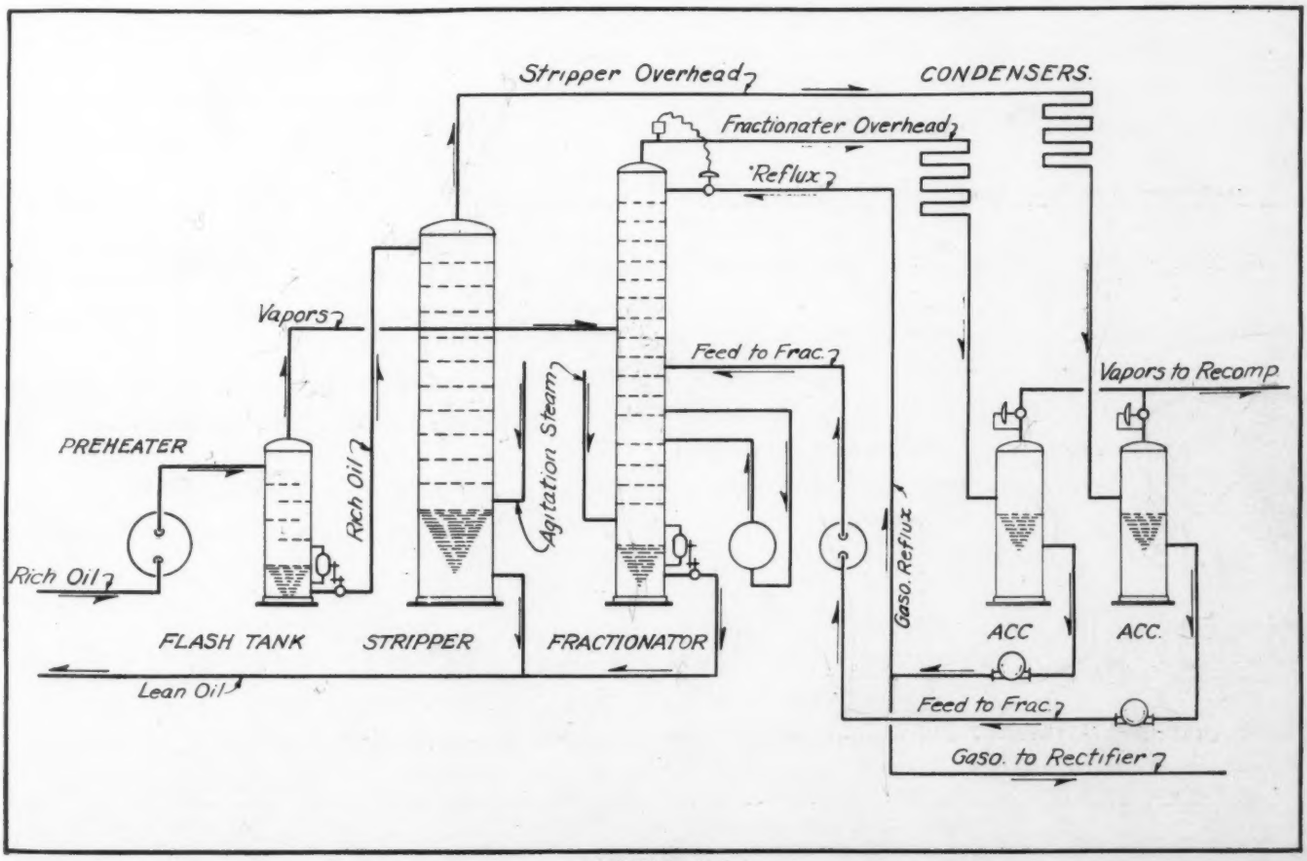


FIGURE 3
Distillation Unit

gas passes on to the high-stage compressors through which it is raised to a maximum pressure of 450 pounds gauge and again cooled. At this point the compressor gas combines with the high-pressure field gas and together flow through the high-stage accumulator and into the absorber.

The dry gas leaving the absorber passes through an accumulator and to the gas distributing system where it is reduced to the necessary pressures for sales, field fuel, plant fuel and dry gas blow off.

Although the high-pressure wet gas from the field is only a small part of the gas treated by the plant it was considered economically correct to build only a high-pressure absorption plant; even though at times all of the dry gas is reduced to comparatively low pressures.

THE SOFT WATER SYSTEM

Figure 2 shows the complete soft water system of the plant. The principle of this system is that all steam generated by the boiler plant, and used for pumps, heating, or as process steam, is condensed and reused as boiler feed water. From this system a small quantity of the soft water is withdrawn and used as make up to the closed compressor jacket water system and also for use in the office and locker room. To compensate for this water used outside of the boiler system and for all loss through leakage and vents, an evaporator is operated to supply a make up of distilled water. The raw water before entering the evaporator is heated to boiling temperature and efficiently de-aerated. The evaporator is heated by live steam and operates at a pressure of about 25 pounds gauge, under which conditions the scale obtained is very brittle and can be easily removed from the evaporator tubes. The amount of evaporator make up varies from 1 to 2 percent of the entire boiler plant load. The operation of this setup is simple and proves the desirability of an evaporator system as a means of water purification particularly with water such as found at Shiells Canyon.

DISTILLATION UNIT

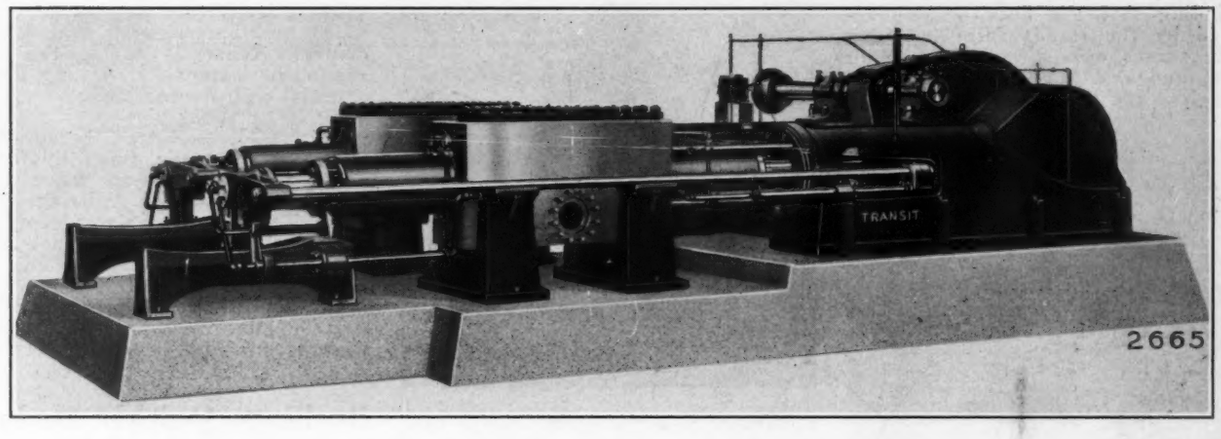
The principal of flow in the distillation unit is shown by Figure 3. The rich oil after leaving the main oil preheaters enters a flash tank, from which the vapors are liberated; and from the bottom of the flash tank the oil travels on to the top of the stripper. This vessel consists of 8 stripping trays and has a large oil reservoir at the bottom. Stripping is accomplished by the use of exhaust steam. The lean oil leaving the stripper has completed its flow through the distillation unit and from there passes on back to the exchangers, coolers and absorber.

The stripper overhead is condensed, dehydrated and pumped through a preheater where it combines with the vapors from the flash tank as feed to the fractionater. The fractionator bottoms, after being thoroughly stripped with live steam, flow directly to the lean oil stream. The fractionator consists of 9 stripping trays and 10 fractionating trays. The overhead from the fractionator is condensed, dehydrated and pumped back, in the conventional manner, for reflux; the excess going as feed to the rectifier.

The separate oil stripper and gasoline fractionator, as described at this plant, has not only greatly increased the ease of operation over the combination still and fractionator, but has also proven economically more efficient.

TRANSIT

POWER DRIVEN HOT OIL PUMPS



The very latest TRANSIT Hot Oil power pump, for use with any type of prime mover.

Size shown is a 5¼" x 18" Horizontal Duplex plunger type for 800° Fahr. oil against 800 lb. pressure. Capacity—240 gallons per minute of hot oil.

Forged steel liquid cylinders with integral stuffing boxes water jacketed.

Liquid cylinders supported along center line of bore by water cooled saddles.

This patented arrangement permits the cylinders to expand in all directions with no change in the alignment.

Can be furnished with all moving parts completely protected by dust proof enclosures, if so ordered.

The selection of pumps for hot oil service is an engineering proposition. As specialists in designing and building such pumps, we offer the services of our Engineering Department to assist you in the proper selection.

NATIONAL TRANSIT PUMP AND MACHINE CO.

OIL CITY, PENNSYLVANIA

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Frick-Reid Supply Corporation
108 N. Trenton Ave.,
Tulsa, Oklahoma

The Lang Company
267 West First South St.,
Salt Lake City, Utah

Standard Supply and Hardware Company
822-838 Tchoupitoulas St., New Orleans, Louisiana

Pratt-Gilbert Company
Phoenix, Arizona

TRANSIT Pump & Engine Co.,
2261 East 15th St.,
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Reeves & Skinner Machinery Co.
2211 Olive Street,
St. Louis, Missouri

Eugene V. Winter Co.,
19 Main Street
San Francisco, California

IDEAS to help plant efficiency

Sturdy Jacking Stand for Large Engines

ALWAYS a tiresome chore around the power plant, jacking or barring engines over to bring some piston to a desired setting is also one of the more frequent causes of accidents to plant personnel.

Finding that the floor sockets required by the stands furnished with their engines were always filling with trash, and that the devices required more leverage than could be managed

by one man, one Diesel-powered station built a sturdy jacking stand from 2-inch pipe, using a short section of 2½-inch pipe on the short section actually in contact with the bar. Angles on the base of the bar hooked over the edge of the flywheel pit, holding the stand against the wedging effect of the bar against the wheel, yet being easily removed or placed without preliminary clearing of the floor.

With this stand it is possible to regulate the leverage to fit the flywheel by setting the base hooks to give any desired spacing between wheel rim and support bar, over which an ordinary crowbar may be used—with no danger of the bar becoming engaged in the flywheel and jerked from the operator's grasp if the unit happens to start unexpectedly.

Condenser Mounted on Top of Storage Tank

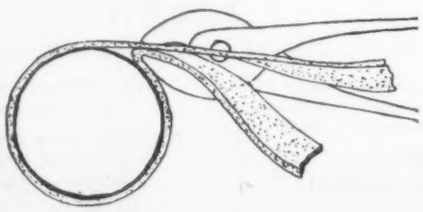
HAVING a considerable amount of off-color gasoline due to pipe line drips, Grimes Gasoline Company, Weleetka, Oklahoma, erected a small column for redistillation, but instead of providing a separate accumulator tank for the condensate, a small condenser was mounted directly above one of the storage tanks. The condenser is of the shell-and-tube type, of

Condenser mounted upon storage tank simplifies accumulation of liquid and provides constant blending of gasoline.

small capacity, both as to vapors and cooling water, but sufficient in size for the problem at hand. The vapors driven from the off-color gasoline are handled in the usual manner, with a vapor line leading directly to the condenser. Liquids dropping out of the shell fall directly into the interior of the storage tank to be blended with the regular. Operation of the rerun unit is handled so that a constant amount of charge is fed to the column heater, and that a comparatively constant composition of the finished gasoline is obtained.

Twisting Kink

WHEN it comes to twisting a "slippery round things," as the oil man often must, the accompanying sketch shows how easy it is to make a good wrench out of a leather strap and a pair of pliers. Wrap the strap around the article to be turned, as shown, and grasp close to the article with the pliers. If it is desired to tighten a thread, turn clockwise as in the sketch. If the thread is to be loosened, simply pull the other way just as with any regular wrench. This idea is of especial value where the article is nickeled or polished and must not be scratched as the leather forms a cushion between the pliers and the metal. If it is thought that a single thickness of leather will not be strong enough it is a simple matter to use two thicknesses or more. Thus the method really has no size limit, provided one has a strap that is long enough. What is more, the strap needn't be leather. Any strong, flexible material will do-even rope.



To be sure, for pipe work a regular pipe wrench is better, because pipe wrenches are made especially for the purpose, and one can more easily develop a powerful twisting action through the handle of a regular wrench. Nevertheless, it is well to know about this kink, as we often find ourselves confronted with a job that we think needs a pipe wrench, whereas with a pair of pliers and an ordinary strap the obstacle may be easily overcome.

Bushings Quickly Made

WHEN standard bushings are unavailable and one is in urgent need of one or more such bushings, there usually is a way in which to make an emergency bushing that will serve the purpose. Babbitt and lead often lend themselves to an occasion of this kind better than anything else.

To apply a babbitt or lead bushing, all that is necessary is to support the pulley in any convenient way so that it is in its correct position around the shaft. That is, it must be concentric. Then by means of putty or any other suitable material build dams around the openings and arrange the mould so that

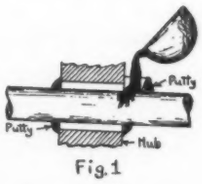


Fig. 1

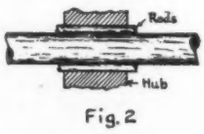


Fig. 2

the metal can be poured. The method is so obvious that detailed explanation is unnecessary. Then pour the metal about as indicated in Figure 1. That's all there is to it.

For split pulleys, if it so happens that the bushing must be exactly an eighth-inch thick, or a quarter-inch, and if there is in stock some round iron rods an eighth- or quarter-inch in diameter, cut the rods to a length slightly greater than the length of the pulley hub. Then use the rods for bushings placed side by side to fill the entire space between the shaft and pulley as shown in Figure 2.

Square stock is better than round

Don't bet your profits

If you got by through 1937 without Dubbscracking, you can thank your lucky stars—but here is a suggestion:

Don't bet another year's profits that you can do it again Don't push your luck too far

Maybe you can't always be lucky

But you can be wise

It's wise to install Dubbs-cracking now

Then 1938 will be a happy New Year for you—with many happy returns

Happy New Year

Universal Oil Products Co
Chicago, Illinois

Dubbs Cracking Process
Owner and Licensor

stock for this purpose because the round pieces will act like rollers in a roller bearing if the pulley is not bolted up sufficiently tight to prevent such motion. For this reason rough round pieces are better than smooth. Use square or rectangular stock in preference to the round if the former is available.

Sometimes the quickest way is to use strips of hardwood laid side by side around the interior of the pulley just as explained above for the rods. Wood is more easily reduced to the proper size than metal. Where there is ample contact surface between the pulley and shaft, wood generally serves the purpose just as well as metal.

Segregating the Centrifuge

REPLACING the usual metal cover for the centrifuge case—which soon becomes dented and distorted enough to lose its gas tightness, if not even discarded because of difficulty in placing or removing it—one company mounted the centrifuge in the station office, and enclosed it, bowl and all, in a wooden case, asbestos lined for fire-proofing.

The entire front and part of the top of the case was hinged to the remainder of the top, and the weight so counterbalanced by a pair of springs that, closed, the springs exerted force to hold the two halves of the case tightly together; and, when opened, the springs served as counterbalance to hold the case open and permit the centrifuge tubes to be removed or replaced easily.

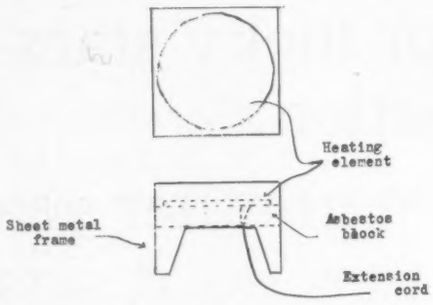
Vented to the outside of the building through a louvred aperture at the back of the case, this centrifuge mounting is explosion-proof, as any gases are carried outside by the current of air set up by the vertical motor for its own cooling, and a concentration of gases from the samples in the centrifuge thus prevented.

By setting an automatic switch in the aperture between door and fixed sections of the case, it is impossible to run the motor with the lid raised, thus forestalling any chance of fire from sparks originating on the commutator of the motor.

Spring-closed cover for this centrifuge supplants the awkward tin top and insures safe running of samples.

Viscosity Sample Heater

FOR preheating viscosity samples a small heater is required which will come to heat quickly, be readily portable and very easy to repair. Such heaters have been made from junk parts and new replaceable heating elements. They are of the simplest possible construction and require a minimum amount of time for repairs or replacements.



Sample Heater

Sketch shows method of assembly. Since the heating element merely rests on the asbestos it may be removed and replaced without tools.

Olean, N. Y. GEO. F. FITZGERALD

Oil Baffle

THIS oil baffle was designed for use in open ditches to hold back all oil and to allow water to continue on through the drainage system.

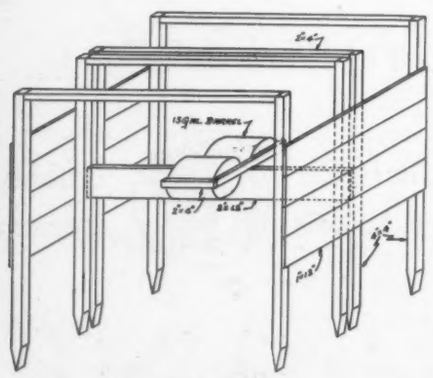
It is needless to say that for smaller baffles, smaller lumber may be used and vice versa.

The following is a description of a 12-foot baffle span that is in successful operation. All lumber used was creosoted for durability in water.

The ditch was cleaned out and banks cut back vertically to about 12 feet across. The cut was for about eight feet. In the center of this vertical cut side were driven two 4 x 4-inch x 10-foot about 3½ feet below the bottom of the ditch, to act as runners for the baffle. A 1-inch clearance was allowed between baffle, runner and side wall. Next, the end 4 x 4s were driven (holes dug) and 1 x 12-inch x 6-foot side walls were assembled to keep dirt from filling in. Two by 4 top braces were added to keep structure in tack. The baffle (2 x 12) was put into the runners. Two 15-gallon air tight drums were attached to the exact center of baffle. A piece of old belting was fastened to both ends of baffle to keep out trash, etc.

The baffle should be about 7 to 9 inches under water, and if not, add weights symetrically to both barrels. The baffle should rise and fall with the water.

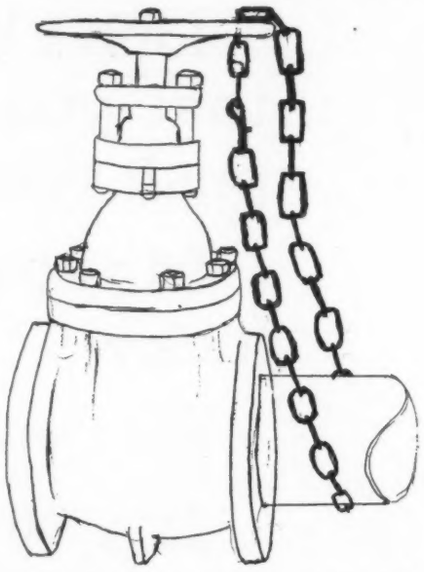
Shreveport, La. E. D. UNDERWOOD



Oil Baffle

Chain Warns Valve Must Be Left Alone

USE OF a short piece of chain with a harness snap welded on one end, drawn through the spokes of a valve wheel, then around the pipe and snapping the other end of the chain in the snap, serves as an excellent warning that the valve is not to be opened or closed save by the operator who has placed the chain there. Such a practice may often save confusion and trouble on the refinery yard.



Texas City. R.E.L.

Warmed Gasoline Settles Quickly

IN TREATING sour gasoline trouble was encountered that after the break occurred there was a very fine suspension of spent lead floating in the gasoline even after the water wash. This results in a darkish haze in white gasolines, and at the same time carries dirt which would block carburetor jets. This gasoline would take considerable time to settle off in sub-zero temperatures, taking 3 or 4 days or longer. A very good remedy for settling this trace of black strap is to put live steam into the gasoline agitator until the gasoline becomes cloudy. When the moisture settles, the spent lead settles with it, thus settling in about 4 or 5 hours and producing a clear, water-white gasoline. This method was found to work satisfactorily, thus saving much time.

Winnipeg, Canada. W.J.D.

Plants Described C.N.G.A. December Meeting

ECONOMIC factors contributing to the continued stability of the Pacific Coast natural gasoline industry, and the flow plans of four new gasoline plants were the features which entertained the 250 who attended the December 9 meeting of the California Natural Gasoline Association. As chairman for the evening, W. W. Robinson of The Texas Company opened the meeting with a discussion of several factors which have preserved the local gasoline industry's economic stability since the decline which followed the flush production days of 1929. Natural gasoline production in California for 1936, Robinson said, was 11 percent greater than for 1935. Statistics for the first 10 months of 1937 indicate that natural gasoline production this year may reach 615,000,000 gallons, or the largest volume produced since 1931.

Drilling operations on the Pacific Coast, he explained, have been so gradual and orderly that few are aware of the progress made by the natural gasoline manufacturer in keeping abreast of the times. Considering important field developments which have stimulated gasoline plant construction or modernization, he cited the eastward extension of the Montebello field; the geophysical discovery of the Ten Section area near Bakersfield; the development of the Wilmington and El Segundo pools near Los Angeles; the proving of the North Belridge extension near Lost Hills; and the deep discoveries in the Greely, Strand and Rio Bravo fields.

Mentioning the considerable expansion which these field developments have brought to the gasoline manufacturer, Robinson pointed out the new plants by The Texas Company and Universal Consolidated Oil Company in the Montebello field; General Petroleum Corporation in Wilmington; Richfield Oil Company and Ohio Oil Companies in El Segundo; The Texas Company at Ventura; Coline Gasoline Corporation at Rincon; Shell Oil Company at El Capitan; and in the San Joaquin Valley, Rancho Gasoline Corporation plant at Grapevine, the Standard Oil Company plant at Greely, and the new and remodelled plants of the Belridge Oil & Gas Company at North Belridge.

The plant descriptions given by the four speakers brought out the increasing trend toward high-pressure absorption on the Pacific Coast. C. L. Parkhill, of Parkhill-Wade, Inc., described the 80,000,000 cubic foot plant of the Belridge Oil & Gas Company, which is designed to operate at 450 pounds. The principal features stressed by Parkhill were: (1) the compact layout; (2) almost complete automatic control; (3) centralized control panels; (4) effective lighting; and (5) safe arrangement of boilers and run-down tanks.

F. S. West, engineer for The Texas Company, discussed the layout and operation of The Texas Company's new plant 17 at Shiells Canyon, near Ventura. West showed the plant to be of the two-stage arrangement for treating low and high pressure field gases. Of unusual interest was his description

The Look Box

of the complete evaporation system for preparing boiler and engine-jacket water.

M. E. Garrison, gasoline plant engineer for General Petroleum Corporation, next described this company's 15,000,000 cubic foot plant in the Wilmington field. Designed with a 75,000 gallon-a-day still, ample means have been provided to take care of any unusual field developments. Garrison pointed out that the steady development of the field, along with attendant low oil-to-gas ratios, placed a severe requirement on the design engineer in order to permit flexibility to meet changing field conditions and maintain maximum extraction efficiency.

Concluding the program, F. W. Wilcox, design engineer with Parkhill-Wade, Inc., described the 20,000,000 cubic foot plant of Rancho Gasoline Corporation which has been built to operate at 450 pounds. This unit, situated in the El Tejon ranch development, is similar in operation to that constructed by the same organization for Belridge Oil & Gas Corporation at North Belridge.

The complete papers describing the four natural gasoline plants mentioned above are presented in the technical section of THE REFINER in this issue.

Conventions

FEB. 14–17	American Institute of Mining and Metallurgical Engineers, Annual Meeting, Engineering Building, New York.
MAR. 7–12	American Society for Testing Materials, Spring Regional Meeting and Group Committee Meetings, Seneca Hotel, Rochester, N. Y.
23–25	American Society of Mechanical Engineers, Los Angeles, Calif.
APR. 13–15	National Petroleum Association, Cleveland, Ohio.
13–15	Petroleum Industry Electrical Association, Dallas, Texas.
17–21	American Chemical Society, Dallas, Texas.
MAY 11–13	Natural Gasoline Association of America, Tulsa, Oklahoma.
14–21	International Petroleum Exposition, Tulsa, Oklahoma.
23–25	American Petroleum Institute, Eighth Mid-Year Meeting, Wichita, Kansas.
JUNE 16–18	Pennsylvania Grade Crude Oil Association, Pittsburgh, Pa.
20–24	American Society of Mechanical Engineers, St. Louis, Mo.

New Reid Vapor Pressure Effective

A REVISED method for determination of Reid vapor pressures of natural gasoline is to become effective as a standard of the Natural Gasoline Association of America January 1, 1938.

Officially known as A.S.T.M. Method D 323-37T, the method originally was developed by the Natural Gasoline Association of America in cooperation with the California Natural Gasoline Association and was adopted as a standard for the industry during the past year by the American Society for Testing Materials.

The "scope" of the new method indicates that it is to be used in the determination of vapor pressures of volatile, non-viscous petroleum products and describes two different sampling procedures. One of these is for products having vapor pressures of 26 pounds or less, and the other for products of higher vapor pressures. In those marginal cases in the vicinity of 26 pounds, where there may be a doubt as to which procedure would apply, it is stated that the determining factor should be the maximum vapor pressure specification of the product to be tested without regard to the numerical value obtained by the test.

Obviously the new method is a combination of A.S.T.M. Methods D 417-35T, adopted as the standard for motor and aviation gasoline vapor pressure determinations in 1935, and A.S.T.M. Method D 323-32T which has been the standard method for testing natural gasoline since 1932. Both of these methods were developed by the N.G.A.A. also. Such a combination gives both the refiner and the natural gasoline manufacturer the same standard for making Reid determinations, thus simplifying the operations of buyer and seller, particularly in the volume transactions for grades of natural gasolines of 26 pounds vapor pressure or less.

Study of the new method reveals that old A.S.T.M. D 417-35T has been used in practically the same form except for minor revisions in procedure and the inclusion in its scope of natural gasoline having a vapor pressure up to and including 26 pounds. The old procedure for natural gasoline, A.S.T.M. D 323-32T, was considerably revised to make it more nearly conform with that of D 417-35T though the air saturation step and intermediate sampling procedure were eliminated. With these corrections made in the old methods, it was a simple step to combine the two into a single standard with the first part covering the lower vapor pressure grades and the second covering grades above 26 pounds vapor pressure. The result is a method which is calculated to yield more uniform and duplicable results on all products wherever they may be run. However, attention is called to the fact that reasonable care must be exercised and that the precautions and specifications of the method must be carefully followed.

The technical committee devoted much of its time for nearly a year in perfecting the method before recommending its adoption as a standard for the industry to the A.S.T.M. Extensive tests, both laboratory and field, were made for the purpose of studying the results obtained by the old and new

methods. A total of 814 tank cars of natural gasoline were tested, many of these being sampled at both point of origin and at destination, in order to obtain the necessary data to make the desired comparisons. Results of these series of tests indicated that D 323-37T gave fractionally higher numerical values in the lower vapor pressure grades thus working a slight economic hardship on the natural gasoline manufacturer. However, the N.G.A.A. did not feel that this handicap was sufficient justification for insisting there be two methods of test covering products in the same general field and made the concession in the interests of uniformity and to provide the refiner with a more convenient and accurate method than the old D 323-32T.

Copies of the A.S.T.M. Method D 323-37T can be obtained from the offices of that organization, 260 South Broad Street, Philadelphia, Pennsylvania, at the following rates: 1 to 9 copies—25 cents each; 10 to 24 copies—20 cents each; 25 to 99 copies—17½ cents each, and larger lots on quotation.

N.G.A.A. 1938 Convention Announced

THE 1938 Convention of the Natural Gasoline Association of America will be held at the Hotel Tulsa, Tulsa, Oklahoma, May 11-13, according to announcement by William F. Lowe, secretary of the association.

The dates chosen for the convention are a particularly fortunate selection for those attending from distant points. The International Petroleum Exposition opens Saturday following the last day of the natural gasoline sessions and thus an opportunity is provided for attending both the convention and the oil show in the closing days of the same week.

Plans for an unusually interesting meeting are already being formed under the direction of a convention committee appointed by J. A. LaFortune, Warren Petroleum Corporation, president of the association. Chairman of this committee is J. W. Vaiden, Skelly Oil Company, Tulsa. Other members are: R. C. Alden, Phillips Petroleum Company, Bartlesville, Oklahoma; W. A. Baden, Warren Petroleum Corporation, Tulsa; R. E. Beckley, Standard Oil Company of California, San Francisco; T. R. Goebel, Shell Petroleum Corporation, Tulsa; J. R. Jarvis, Lone Star Gasoline Company, Dallas, and P. M. Raigorodsky, Glen Rose Gasoline Company, Tulsa.

Due to widespread interest in the vapor lock-vapor loss road tests conducted during the past summer in cooperation with the Western Petroleum Refiners Association, Chairman Vaiden indicates that at least one whole session is to be devoted to discussion of their results and their significance to the natural gasoline industry. It was also stated that present plans of the committee call for several papers dealing with plant operating problems and manufacturing methods as well as reviews of significant developments in refinery processes affecting natural gasoline operations and discussions of gas contracting problems. A well balanced program is assured.

Further Agreement by Cracking Licensors

FURTHER clearing up of the patent situation with regard to various cracking processes follows the recently announced agreements reached by Universal Oil Products Company, The Texas Company and Gasoline Products Company and Donnelly Process Corporation. For the purpose of clarity of the record the releases from the companies mentioned are given.

Universal Oil Products Company in its release states that at 7 o'clock on the evening of December 1, in the New York offices of Universal Oil Products Company, an agreement was signed which clarified and defines the respective patent rights of licensors and licensees of the Dubbs and other cracking processes.

"It was an agreement between Universal Oil Products Company and The Texas Corporation, which grants Universal Oil Products Company full rights to give immunity to all of its licensees under all the cracking patents owned by The Texas Company, Gasoline Products Company and others.

"The agreement was affirmed and also signed by officers of Standard Oil Company of New Jersey, Standard Oil Company (Indiana), The Atlantic Refining Company, Gulf Oil Corporation, and Gasoline Products Company, Inc., thus granting Universal Oil Products Company full licensing rights under their respective cracking patents.

"A similar agreement was signed some time ago between Universal Oil Products Company and Consolidated Oil Corporation.

"Gasoline Products Company, Inc. reserves the right to continue licensing cracking processes but only under the patents owned by it and associates. The agreement does not grant rights under Universal Oil Products Company's patents or immunity from infringement suits by Universal Oil Products Company against them or their licensees.

"The agreement is of importance to the refining world because:

"First, its immediate effect will be the dismissal of law-suits brought by The Texas Corporation against Waggoner Refining Company and the Solvex Refining Company of Texas and Sunray Oil Company of Oklahoma and two suits brought against National Refining Company of Cleveland, Ohio, by Gasoline Products Company. All of these companies are licensees of Universal Oil Products Company.

"Second, it will eliminate the burden of further costly litigation.

"Dubbs licensees are and always have been fully protected by Universal Oil Products Company's guarantee against any expense or damage from patent litigation and Universal Oil Products Company has always successfully defended its licensees when sued.

"Under the new agreement, however, Universal Oil Products Company can go even farther. It can now assure them against attack from any of the signatory companies.

"Over the past decade enormous sums have been spent by both sides in court battles, while the direct loss suffered by disturbance of operations, diversion of the attention of executives from their offices to the courtroom, is incalculable.

"Now these needless losses will be largely, if not completely, eliminated, so far as this field is concerned."

Following is the statement released by The Texas Company:

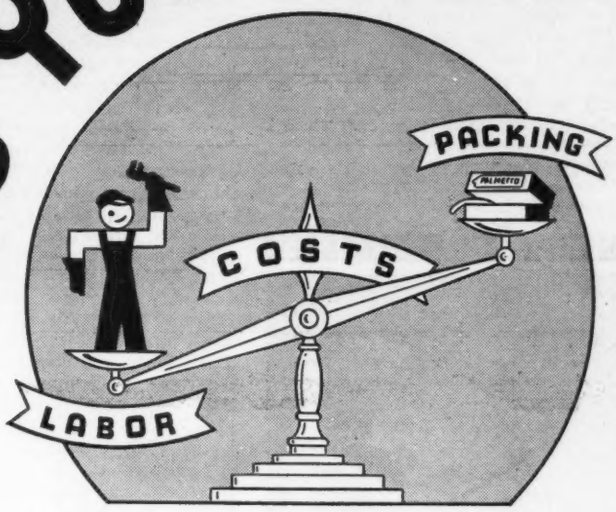
"The Texas Company announces that it has sold to Universal Oil Products Company a non-exclusive right to grant licenses under the oil cracking patent rights of The Texas Company to all of the present and future licensees of Universal Oil Products Company. This development will be of special interest to those who have acquired licenses from Universal Oil Products Company since January 1, 1931, and to those who may hereafter acquire a license from that company.

"R. J. Dearborn, president of Texaco Development Corporation, stated that the new settlement recognizes the value and importance of the Behimer Clean Circulation Patents which were issued to The Texas Company in 1932 and for which The Texas Company has been vigorously contending for a long time. As an immediate result of the settlement, The Texas Company will now promptly dismiss the patent infringement suits which it has been actively prosecuting upon the Behimer Patents against Solvex Refineries, Inc., at Tyler, Texas, Sunray Oil Company at Tulsa, Oklahoma, and National Refining Company at Fort Scott, Kansas. All of these defendants are present licensees of Universal Oil Products Company.

"As a result of the settlement, Universal Oil Products Company has also acquired a non-exclusive right to grant licenses under the oil cracking patents of Gasoline Products Company and others. Suits which are now being prosecuted by Gasoline Products Company against Waggoner Refining Company at Wichita Falls, Texas, and against National Refining Company at Toledo, Ohio, will be dismissed in view of the fact that the defendants are licensees of Universal Oil Products Company. A suit that is being prosecuted at New Orleans by Universal Oil Products Company against Chalmette Petroleum Corporation, which is a licensee of Gasoline Products Company, will also be dismissed. Provision has also been made whereby the other licensees of Gasoline Products Company may obtain immunity under the oil cracking patents of Universal Oil Products Company."

The statement from the Donnelly interests reads as follows: "Donnelly Process Corporation announces that it is now in a position to obtain for its present and future licensees immunity from suits for infringement under the oil cracking patent rights of Universal Oil Products Company for cracking units licensed by Donnelly Process Corporation under its oil cracking patent rights which include those of The Texas Company. This has resulted from the recently announced settlement between The Texas Company and Universal Oil Products Company. It will be recalled that since July 1, 1936, Donnelly Process Corporation has had the right to grant licenses under Gasoline Products Company's oil cracking patent rights as well as those of The Texas Company which include the very important Behimer clean circulation patents."

DO YOU KNOW..



IT COSTS MORE TO REPACK A PUMP THAN THE PRICE OF THE PACKING ITSELF

Experience has shown that the labor charge, the time wasted, the stoppage of production, far outweigh the actual cost of the packing.

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BUTANE, NAPHTHAS AND ALL LIGHT STOCKS

An asbestos packing carrying a compound to resist the action of these fluids. Does not contain glycerine. Its use insures proper lubrication of pump, and avoids overheating and friction.

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SQUARE **PALCO** PLAITED PACKING

FOR
Water, Centrifugal Pumps

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SUPER CUTNO PACKING

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Pump Failures Would Be Less Frequent if the proper packing were selected to resist the destroying action of the liquids or gases pumped.

SEND FOR ABC PACKING CHART OF SERVICES. ALSO FREE WORKING SAMPLE FOR PRACTICAL TEST. STATE SIZE OF PACKING AND CONDITIONS OF SERVICE.

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Fifth Edition "Petroleum Facts and Figures" Printed

PUBLICATION of "Petroleum Facts and Figures," Fifth Edition, 1937, has been announced by the American Petroleum Institute.

The edition, which is 6 by 9 inches in size, contains about 250 pages, and is printed in modern, legible type on India paper, is the first to be published by the petroleum industry trade association since 1931.

Effort has been made to incorporate in the new edition all pertinent data available regarding the industry, so that the one volume will be a complete and comprehensive work.

Subject matter is divided into eight sections. The first, concerning utilization, shows various uses to which petroleum and its products are put, with consumption figures by years. The chapter reveals that more than 1,750,000,000 barrels of petroleum products are consumed annually by world industries, transportation, farms and homes. The United States, with only 6.5 percent of the world's population, consumes 62 percent of the total, an indication of the dependence of this country's higher standards of living upon petroleum.

The second chapter, covering production, shows the output of crude oil by continents, nations, states, and fields since production records first were kept. Allied subjects, such as petroleum reserves, deep drilling records, crude oil prices, and production of other products also are presented. Data indicate that the petroleum industry contributes $21,000,000,000 to the economic wealth of the 22 oil-producing states of this country.

Transformation of raw materials into usable products is considered in the third chapter, which deals with refining. Here the figures reveal the remarkable progress made in the refining branch of the industry, with new processes producing twice as much gasoline from a given quantity of crude oil, and improving quality and reducing prices all along the line.

An insert presents one of the first complete lists of principal petroleum products to be compiled in recent years. The list, prepared with the cooperation of refinery technologists throughout the country, shows how extensively petroleum enters the industrial and social life of today, and indicates the possibilities of continued progress in widening petroleum's sphere of usefulness. The chapter includes complete and current statistics on refining operations.

Markets and prices are covered in the statistics of the fifth section, which presents a complete record of gasoline prices and taxes in 50 cities, and shows that since 1920 retail prices of motor fuel have moved to half their former level.

Opposite trends are shown in the sixth section, where comprehensive data on taxation disclose how heavily the petroleum industry and its customers are levied upon for the support of government. The figures show a growth in the annual petroleum tax bill nearly to $1,200,000,000, with approximately $1 of every $8 in taxes collected by federal, state, and local taxing jurisdictions coming from or through petroleum sources.

The seventh, or general, section presents facts and figures on the industry's capital investment, pay rolls, earnings, etc. Statistical evidence is presented to show that the industry earns far less than government collects in petroleum taxes; that the industry invests $490 for every motor vehicle on the roads in order to assure adequate supplies of fuels and lubricants for each vehicle. Contributions of the industry to other industries, and to employment, wages, and trade, through continuing heavy purchasing of supplies, also are presented.

The eighth section, comprising an appendix, presents complete condensed tables covering a long period of petroleum exports, imports, consumption, production, refining operations, etc. Also presented are lists showing institute officers, board of directors, and standing and special committees; lists of petroleum and allied trade associations, both national and state; a complete list of Institute technical and other publications; and an index.

The volume contains all the pertinent statistical information presented in the first four editions of "Petroleum Facts and Figures," with all data modernized. Copies are priced at 75 cents per single volume, with discounts for quantity.

GASOLINE PLANT & REFINERY EQUIPMENT

Tulsa Boiler & Machinery Co.

WEST TWENTY-FIRST STREET & UNION AVENUE TULSA, OKLAHOMA

▼ PLANT ACTIVITIES ▼

Gasoline Plant: Deep Oil Development Company, Wichita Falls, Texas, has completed construction of a 4,000,000 cubic foot per day natural gasoline plant in the K-M-A field with residue gas being used for repressuring operations. This is the company's second plant in North Texas.

Gasoline Plant: Aldon Gasoline Company has completed a 10,000,000 cubic feet per day, natural gasoline plant in the Stone section of the Burrton pool, Reno County, Kansas. Installation is reported to have cost $200,000.

Cracking Unit: Valley Refining Company, Roswell, New Mexico, has announced plans for construction of a 500-barrel Dubbs cracking unit at its 750-barrel refinery at Roswell. Construction is under direction of Born Engineering Company of Tulsa.

Enlarging: Oriental Refining Company, Denver, Colorado, recently incorporated by Sidney H. Keoughan and associates, has purchased the refinery erected in 1935 by Denver Refining Company at reported price of $75,000. The company states it will spend $150,000 to enlarge and improve the plant to capacity of 1500 barrels per day and will erect 150,000 barrels storage. Oriental Oil Company, an allied concern with production in western Kansas, will supply crude.

Refinery: Yale Oil Corporation of South Dakota has announced plans for construction of a 1500-barrel skimming plant at Kalispel, Montana, to process crude from the Cut Bank field. Completion is scheduled for April 1, 1938.

Enlargement: Imperial Oil Company, Ltd., is erecting a 3000 barrel addition to its 4000 barrel plant at Regina, Saskatchewan, Canada. Cost of the new unit and other additions is reported at $350,000, with completion scheduled for June, 1938. The company will spend about $500,000 for installation of a new cracking unit at its Calgary refinery.

Enlarge: Southwestern Oil & Refining Company, Corpus Christi, will not build the proposed refinery at Lake Charles, Louisiana, as announced through the trade press recently. Instead, the company will erect a new 5000-barrel unit at its Corpus Christi refinery, increasing capacity at this plant to 8000 barrels per day.

Enlarge: Southern Minerals Corporation, Corpus Christi, Texas, is reported planning to increase capacity of its natural gasoline plant in the Saxet field to handle an additional 50,000,000 cubic feet of gas a day.

Refineries: The U. S. S. R., reports that plans are being laid for extensive modernization of refining processes and further refinery construction during the next year or two. Production of natural gas and gasoline is to be increased and stripped gas will be used for refineries for fuel instead of fuel oils. Work is underway on four installations of the catalytic polymerization process licensed by Universal Oil Products Company.

Gasoline Line: The proposal to build a gasoline line from West Texas to Des Moines, Iowa, has again been revived following proposal of a 15 percent increase in freight rates now being asked by the rail lines. Talk of the gasoline line has been frequent over the past two years and the route would parallel for part of its distance the trunk lines out of the old Ranger area into Oklahoma. The distance is about 1300 miles and the cost is estimated at $12,000,000.

Refinery: Economy Oils, Ltd., Calgary, Alberta, Canada, with production in the Turner Valley field, is erecting a 500-barrel skimming plant to produce its needs for its 85 distributing outlets in surrounding territory.

Cracking Unit: Panhandle Producing & Refining Company is completing installation of a 1000 barrel Dubbs cracking unit at its Lueders, Jones County, Texas, refinery.

Building: Premier Oil & Refining Company, Cotton Valley, Louisiana, is

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building a new 3000-barrel skimming plant to operate on 62 gravity Cotton Valley production. The company is also building an absorption-type natural gasoline plant to process rich gas from the Cotton Valley leases. Completion is scheduled for February 1.

Carbon Black Plant: Magnolia Petroleum Company has been granted permit by the Oklahoma Corporation Commission to erect a carbon black plant near Stonewall, Oklahoma, on the edge of the Fitts pool. Plant is to cost around $750,000 and is to be in operation early this spring. Residue gas from gasoline plants in the Fitts field will be processed.

Carbon Black Plant: Hagy Harrington and Marsh, Inc., have been granted permit by the Oklahoma Corporation Commission for a large carbon black plant to be erected near Guymon in the Oklahoma Panhandle. Likewise a permit has been granted for construction of a "GasTex" plant to Atlas General Carbon Company, also to be located near Guymon.

Gasoline Plant: Warren Petroleum Company and Western Supply Company have started construction of a 35,000-gallon-per-day natural gasoline plant, well-pressure type, near Aransas Pass, Texas. The plant will be in operation within the next few weeks with sufficient equipment to process 70 to 80,000,000 cubic feet of gas a day.

De-Salting System: Bay Refining Company, Bay City, Michigan, following recent completion of its 3500-barrel skimming plant, has installed a desalting process consisting of two units licensed by Petroleum Rectifying Company.

De-Salting System: McNutt Refining Company, El Paso, Texas, has recently completed installation of a one-unit system of the de-salting process licensed by Petroleum Rectifying Company.

Repairs: Bay Petroleum Corporation, McPherson, Kansas, which is affiliated with Bay concerns of Denver, Colorado, suffered damage by fire December 21, which will require five or six weeks to repair. The plant is now being rebuilt and is also being equipped with a de-salting system licensed by Petroleum Rectifying Company.

Tanker: Construction of a second 18,500-ton welded tanker for The Atlantic Refining Company has been started by Sun Shipbuilding and Dry Dock Company, Chester, Pa. The vessel is scheduled for delivery early in August, 1938. The "J. W. Van Dyke," a tanker of the same tonnage and welded construction launched from the Sun shipyards in November, is scheduled for delivery to The Atlantic Refining Company this month. The two tankers are the world's largest welded ships now under contract.

Tanker: The S.S. "Esso Houston," sixth of ten new oil tankers in a $16,000,000 building program of Standard Oil Company of New Jersey, was launched by Federal Shipbuilding and Dry Dock Company, subsidiary of United States Steel Corporation, at Kearney, New Jersey, December 18.

It follows two sister ships of similar construction completed by the same yard earlier this year. All three ships were from a design Federal adopted in 1934 to improve the efficiency of oil carriers.

The "Esso Houston" is an oil burner with a sea speed of over 12 knots. She is 450 feet long, has a deadweight capacity of 13,000 tons, and a cargo capacity of over 100,000 barrels.

Enlarge: Amsco Refining Corporation, Corpus Christi, has announced plans for a 6000-barrel addition to its present refinery to bring total capacity to 10,000 barrels a day.

Refinery: Ypiranga, S. A. Companhia Brasileira de Petroleos, Rio Grande do Sul, Brazil, South America, has completed construction of a refinery with present capacity reported at 2000 tons per month. Plans call for enlargement to 5000 tons per month in the near future. The company was formed by Argentine, Uruguaian and Brazilian capital.

Refinery: Universal Oil Refining Company, has been formed with plans to erect a small refinery at Pueblo, Colorado. Jack Harris, president, and H. S. Newman, superintendent, are reported negotiating for the site of the proposed plant.

Gasoline Plant: Phillips Petroleum Company has completed construction of its natural gasoline plant in the Goldsmith field, North Ector County, Texas, which will process 100,000,000 cubic feet of gas daily with a yield of 60,000 gallons of gasoline. An experimental polymerization plant has been erected in conjunction with the natural gasoline project.

Gasoline Plant: Tide Water Oil Company, in the Cayuga field of Anderson County, Texas, is operating an experimental plant taking gas from the Lower Trinity gas sand, stripping natural gasoline from it and returning it to the Woodbine sand, the principle oil producing horizon in this field. Should the experiment prove successful it is reported the company plans to erect a large natural gasoline and gas repressuring plant in this area.

Acid Treating: Gulf Oil Corporation, Port Arthur, Texas, has taken license for use of the Stratcold acid-treating process through the Stratford Development Corporation. The first unit with daily capacity of 12,000 barrels, is now being constructed at the refinery.

Cracking: Cosden Oil Corporation, Big Springs, Texas, is installing a new Dubbs cracking unit of the selective type and completion of this work will increase skimming and cracking capacity of this plant to 17,000 barrels per day. The new unit is being erected at a reported cost of $600,000 and will be completed about April 1, 1938.

Construction: Standard Oil Company of Louisiana, Baton Rouge, is planning erection of a new addition to its refinery for the manufacture of aviation gasoline.

Cracking: Pure Oil Company, Nederland, Texas, is reported planning early erection of an additional 21,000-barrel combination-type cracking plant at a reported cost of over $2,000,000. This follows recent completion of a combination selective cracking unit at this same refinery.

Gasoline Plant: The Duval Gasoline Company, Houston, has been formed by the Benedum and Trees interests through Republic Oil Refining Company and Standard Oil Company of Kansas with a capital stock of $500,000. The company has announced plans for erection of a natural gasoline plant in the Sweden oil district of Duval County, Texas, to cost around $250,000. Officers include D. W. Hovey, president; W. J. Blue, vice president; L. E. Loeffler, secretary-treasurer. The new plant will have capacity of 8,000,000 cubic feet of gas a day according to reports.

Tubular Heat Exchanger Standards

HEAT Exchange Institute announces publication of Standards of the Tubular Exchanger Section covering mechanical, construction and thermal standards for shell and bare-tube heat exchangers. The standards contain data on exchanger shells, tube sheets, baffles, support plates, tubes, material specifications, fouling factors and thermal design data. Copies may be secured from C. H. Rohrbach, Secretary, 90 West Street, New York, at 75 cents each.

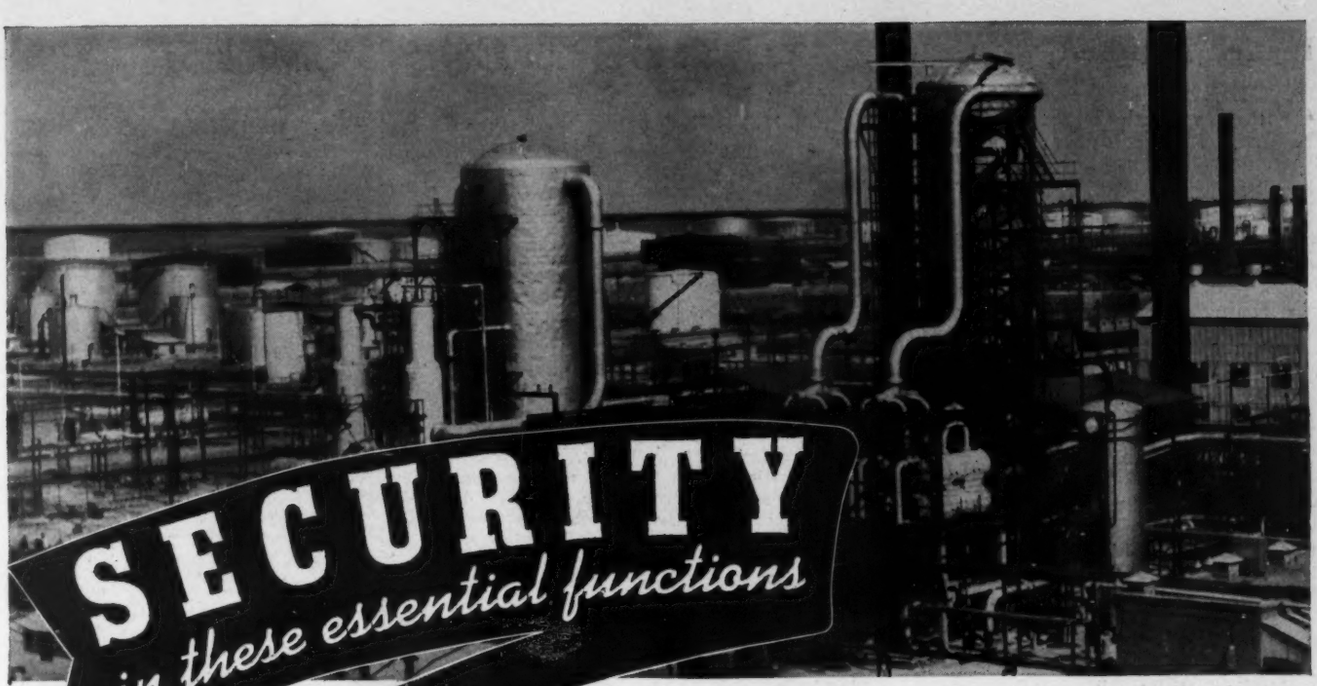
Publish "The Science of Petroleum"

THIS is a comprehensive treatise of the principles and practice of the production and refining of mineral oil. Years of planning and research have gone into the making of this work, which will be published in January, 1938. The chief American editor is Dr. B. T. Brooks, consulting chemist, who was assisted by Professor G. Granger Brown, F. G. Clapp, F. J. Fohs, Dr. Per K. Frolich, Dr. V. R. Gargias, Dr. J. B. Hill, and W. A. Peters. The British editors are Dr. A. E. Dunstan, Professor A. W. Nash, and Sir H. T. Tizard.

The contributors number 322 and represent a cross-section of the greatest living authorities on the subject of petroleum in all its aspects. The result is an authoritative reference work of immeasurable value to the petroleum chemist, geologist, and engineer.

This is a truly international project, editors in all of the leading oil countries having been at work simultaneously in its preparation. Nearly half of the total contributions are from America, the balance coming from England, Holland, Germany, France, etc.

The Science of Petroleum will be issued in four volumes, each about 700 pages and fully illustrated, and Walter C. Teagle contributes a Preface.



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ELLIOTT REFINERY AND POWER PLANT EQUIPMENT

▼ BUSINESS NOTES ▼

Ipatieff Honored

A DINNER and meeting to celebrate the seventieth birthday of Vladimir N. Ipatieff, director of chemical research for Universal Oil Products Company, whose researches have given to the world new methods for producing super motor fuels, was held by the Chicago Section of the American Chemical Society November 26, 1937. More than 600 chemists and friends of Dr. Ipatieff attended the dinner, which was immediately followed by a symposium. Dr. J. C. Morrell, chairman of the Chicago section, presided.

Roger Adams gave a brief foreword, following the dinner, after which Hiram J. Halle, president of Universal Oil Products Company, spoke of Dr. Ipatieff and his important achievements, stressing the greater opportunity which he enjoyed in this country in the conduct of fundamental research than would be possible in the land of his birth and paid tribute to the contributions of this man who has worked so long in the field of science.

Dr. Ipatieff was born in Russia but is now an American citizen.

Dr. Ipatieff followed with a short but interesting "Retrospect" and this part of the program was concluded with a brief epilog by Dr. Harrison E. Howe, editor of the Journal of Industrial and Engineering Chemistry.

At the symposium following the dinner Dr. Ipatieff turned eyes to the future in an address "Catalysis, the Chemistry of the Future." This was followed by a paper by Homer Adkins of the University of Wisconsin, "The Ipatieff Method of Hydrogenation." The meeting closed with "The Philosopher's Stone of Today," by Thomas Midgeley, Jr., inventor of Ethyl gasoline and vice president of Ethyl Gasoline Corporation.

During the World War Dr. Ipatieff was in supreme command of all chemical activities of the Russian government, with the rank of lieutenant general. His discoveries are the basis of many industrial processes, particularly in the refining of petroleum and the synthesis of hydrocarbons. He pioneered in high-pressure hydrogenation of organic compounds. His more recent work has been concerned with the effect of catalysis on the decomposition of organic compounds and the polymerization of olefins.

Dr. Ipatieff's work has been internationally recognized. He was elected a member of the Russian Academy of Science years ago and was recently expelled for political reasons. He is a member of the Academy of Sciences of Gottingen. An honorary doctor's degree was conferred on him by the University of Munich and the University of Strassbourg. He is an honorary member of the Deutsche Chemische Gesellschaft. He was made a commander of the Cross of the Legion of Honor by the French government and was a recipient of the Berthelot medal.

Following the revolution in Russia he became president of Central Chemical Bureau and was the founder of the High Pressure Research Institute. A large part of his work has recently been published in the book entitled "Catalytic Reactions at High Temperatures and Pressures."

DR. V. N. IPATIEFF

APPOINTMENT of W. E. Wechter as manager of oil and gas engine sales, Atlantic Division, is announced by Worthington Pump and Machinery Corporation. Wechter succeeds R. L. Howes, recently resigned.

In his new duties, Wechter will supervise oil and gas engine sales in the Atlantic seaboard territory, in which are the Worthington offices at Boston, New York, Philadelphia, Washington and Atlanta.

Since his graduation from Purdue University in 1923, Wechter has been connected with the Worthington organization, having held successively the positions of salesman in Atlanta territory, Atlanta district sales manager, Detroit district sales manager, and assistant manager of the oil and gas engine division at Harrison, New Jersey. He will now make his headquarters at the Worthington office, 2 Park Avenue, New York.

APPOINTMENT of T. M. Robie as manager of the Diesel sales division of Fairbanks, Morse & Company, has been announced by A. C. Dodge, vice president in charge of sales.

Robie has been associated with Fairbanks-Morse since he returned from World War overseas service in 1919, serving in numerous capacities in the manufacturing and sales division. Since 1932 he had been in charge of Diesel sales to resale manufacturers.

DR. E. H. LESLIE, authority on the chemical process industries, has joined the technical staff of Blaw-Knox Company, Pittsburgh. In his new capacity, Dr. Leslie will be charged with the supervision of the design and fabrication of operating units for the chemical and oil refining industries.

Dr. Leslie is best known to the industrial world for his work as consulting engineer and for his operation, since 1923, of the Leslie Laboratories at Ann Arbor, Michigan. Through his researches, he has been prominently influential in the application of advanced chemical engineering to the problems of the chemical, petroleum refining, and processing industries generally.

DR. E. H. LESLIE

Dr. Leslie received his bachelor's degree at the University of Illinois, with the class of '13, and the degree of Doctor of Philosophy at Columbia in 1916. For eight years, he was professor of chemical engineering at the University of Michigan.

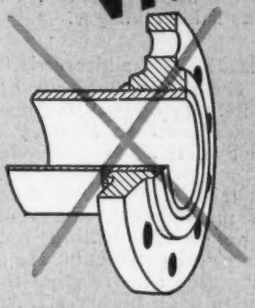
THE CRANE CO., Chicago, has formed a Division of Engineering and Research, which will comprise the existing Division of Research and Development and the Product Engineering Department of the company. The new division has been formed to coordinate all engineering activities of the company, and further its progress in its diversified fields. The importance and growth of this technical work have demonstrated the advisability of maintaining a complete and well-staffed engineering division, free from all responsibilities except those relating to engineering, research, design, and experimental work.

L. W. Wallace, for the past three years director of engineering and researches of the Association of American Railroads, has been appointed director of the Division of Engineering and Research.

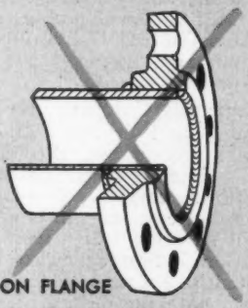
CHARLES E. WILSON of Bridgeport, Conn., vice president in charge of General Electric Company's appliance and merchandise department since 1930, was recently elected executive vice president of the company, a new position.

At the same time, Philip D. Reed was elected assistant to the president. Reed entered the employ of General Electric Company in 1926, and since 1934 has been general counsel of the lamp

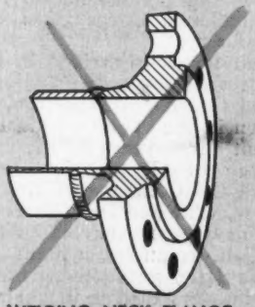
MIDWEST VAN STONE WELDING NIPPLE makes the *ideal* flanged joint for welded piping systems



SCREWED AND WELDED FLANGE



SLIP-ON FLANGE
WELDED FRONT AND BACK

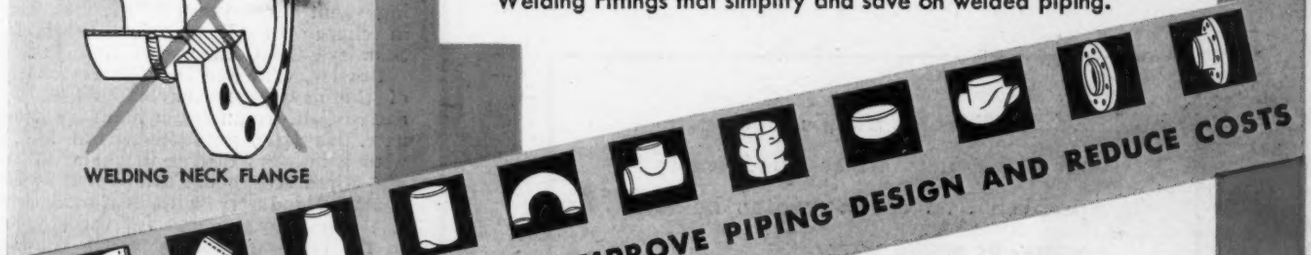


WELDING NECK FLANGE

For making connections to boilers, pumps, valves and other flanged outlets (and where piping must be frequently cleaned or inspected for corrosion), Midwest Van Stone Welding Nipples have a tremendous advantage over flanges that are welded to the pipe (see drawings at left). The swivel flange of the Nipple makes it unnecessary to accurately line up the bolt holes before welding; "setting up" is simple and quick because no special clamps or jigs are required to hold the face of the flange absolutely perpendicular to the axis of the pipe. The result is a real saving in time and cost of welding.

Another important economy is in erection. Field organizations report a saving of 25% in erection time for making up a joint using Midwest Van Stone Welding Nipple in comparison with flanges rigidly fixed to the pipe; this saving is even greater when the flanges are on bends.

Ask for Bulletin WF-36 which gives complete data regarding Midwest Van Stone Welding Nipples . . . and other Midwest Welding Fittings that simplify and save on welded piping.



MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS

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department with offices in New York.

Wilson, a native New Yorker, has been with General Electric Company and one of its constituent companies, Sprague Electric, since 1899. Few industry executives have had the broad experience which he brings to his new assignment. Beginning as an office boy 38 years ago, he has served in practically every function of the business and in many capacities.

A "SWEETENING plant on wheels" enables Perco, Inc., of Bartlesville, Oklahoma to demonstrate the merits and economies of the Perco copper sweetening process on the home grounds of interested refiners and natural gasoline manufacturers. A pilot copper sweetening plant has been installed in an especially built, all-steel trailer about the size of an ordinary house trailer. The plant is an exact duplicate of commercial sized units, complete in every detail, and is capable of sweetening between 25 and 40 barrels of gasoline per 24-hour day. The interest already shown in this novel miniature plant and the number of requests received for its services indicate that it will be very busy for several years.

This test plant can be driven right to the refiners door, tied into his gasoline stream just before it goes into his present sweetening equipment, and proceed to process his product under identically the same conditions as does his present equipment. It is very simple, therefore, to check statements that in the more than 50 commercial units now in operation, noticeable reductions in treating costs have been accomplished.

Analyses of samples of the product sweetened by his present and by the copper sweetening process enable the refiner to compare the two products for color, color stability, gum, induction period, degradation of octane rating, lead susceptibility, tetraethyl lead savings to specified octane number and any other tests required locally for an economic comparison.

MURPHY DIESEL Company, Ltd. of Milwaukee, Wisconsin, announces the appointment of George P. Hough as sales manager.

B. B. MORTON addressed the Bradford Group, Department of Standards and Tests of the National Petroleum Association on Monday evening, December 6, 1937, at Wellsville, New York.

In his talk he discussed the applications of nickel steel, nickel cast iron and Monel in the drilling, production and refining of petroleum. He also discussed the use of nickel steel and nickel cast iron in such highly stressed automotive parts as camshafts, crankshafts, transmissions, and gears. Morton is a member of the Development and Research Division of The International Nickel Company, Inc.

THE Lummus Company, New York, designers and erectors of refining plants, has announced the establishment of a Pacific Coast office at 411 West Fifth Street, Los Angeles, with V. O. Bowles, engineer, in charge. The office will be under the supervision of E. R. (Gene) Smoley, who recently represented The Lummus Company in connection with the design of a 14,000-barrel combination selective cracking unit now under construction for General Petroleum Corporation at Torrance refinery.

Dr. Smoley, who arrived in Los Angeles December 8 to work out details for West Coast representation, is widely known in the refining industry, having spent three years in the Far East in charge of all technical work for Standard Oil Company of New Jersey.

Bowles, who will be in direct charge of the new Los Angeles office, is a native Californian and a Stanford graduate. He later graduated from M.I.T. with a masters degree in chemical engineering. Aftr some time spent in the chemical industry with National Aniline Company, he was for three years in the refining department of Humble Oil & Refining Company at Houston.

NORTON McKEAN was elected vice president of American Meter Company at a recent board meeting of the directors. McKean first became associated with American Meter Company in 1919 as superintendent of its Boston plant, after which he was made general superintendent of the corporation and manager of its Albany, New York, plant— D. McDonald & Co. Works. He will continue in those executive duties.

THE Lincoln Electric Company, manufacturers of arc welding equipment, Cleveland, Ohio, announce the appointment of Robert H. Schuster to the sales staff of the Pittsburgh office,

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Our continuous check-up service is **gratis to our customers.** It produces real results!

EVERY TYPE of chemical or equipment for any water conditioning problem . . . cooling water, boiler water, or waste water.

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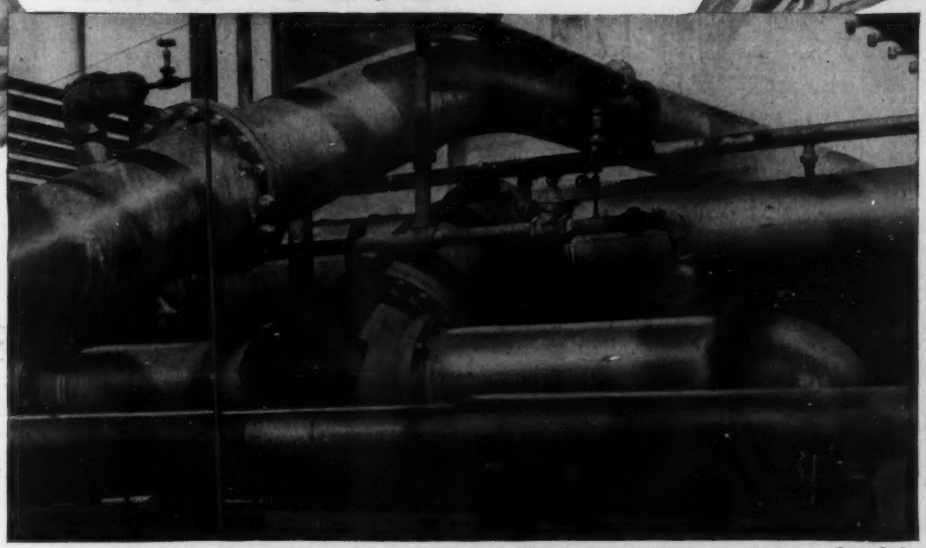


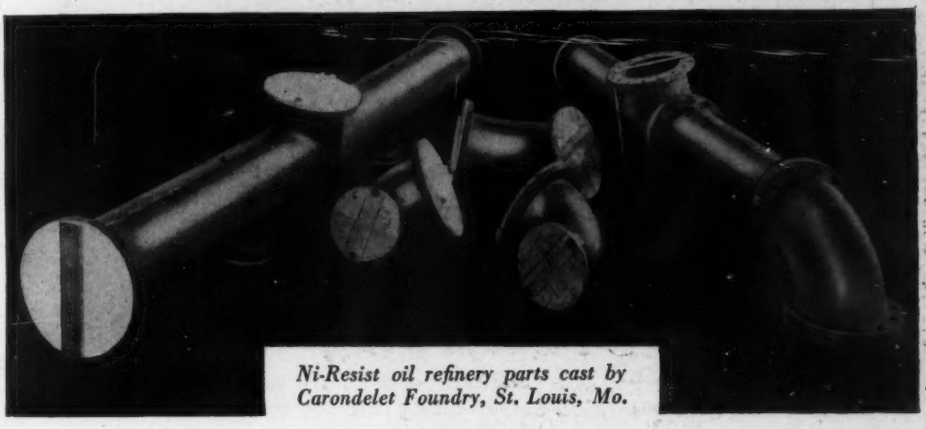
Straight-run gasoline vapor manifold at a Kansas oil refinery. Ni-Resist castings produced by Carondelet Foundry, St. Louis, Mo., installed by Winkler Koch Engineering Co., Wichita, Kansas.

... So say engineers after replacing cast and wrought oil still lines with Ni-Resist

BECAUSE of rapid deterioration of cast iron and steel pipe in oil condenser lines, the Winkler Koch Engineering Co. turned to Ni-Resist. Read what *they* have to say about this corrosion-resistant Nickel-copper-chromium alloy:

"We have found Ni-Resist headers and condensers following vapor lines such as this installation very satisfactory. For many services in petroleum refineries it is by far the best alloy of any kind that we have encountered. These services are, in general, where metals are in contact with raw gasoline vapors or gas at temperatures within the range of condensation of moisture; and pumps and valves handling raw gasolines. There is no oil in the ordinary refinery so corrosive to pumps, for example, as raw cracked gasoline; and probably next to that is untreated light straight-run gasoline. Reciprocating pumps handling these oils give long service when liners and valve assembly are Ni-Resist also.

"In automatically controlled air actuated valves used with liquid levels, gas pressure regulation, liquid reflux control and the like, Ni-Resist trim has given much better service than other materials tried."



Ni-Resist oil refinery parts cast by Carondelet Foundry, St. Louis, Mo.

Ni-Resist is an ideal and relatively inexpensive material for this class of service. In addition to superior corrosion-resisting properties, as shown in the table, Ni-Resist affords good mechanical properties. Consultation on the selection of pressure and corrosion-resisting alloys is invited. Write to:

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NI-RESIST

TYPICAL DATA

The Relative Corrosion Resistance of Cast Iron and Ni-Resist

Corrosion Medium	Comparative Rates of Corrosion Ni-Resist	Cast Iron
Hydrochloric Acid 5%	1	62.0
Sulphuric Acid 5%	1	185.0
Carbon Tetrachloride	1	2.0
Fuel Oil	1	1.0
Magnesium Chloride 10%....	1	2.4
Sea Water	1	3.7

(*Note:* These data were determined in static tests under constant conditions of time and temperatures.)

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

926 Manchester Boulevard, N. S., Pittsburgh, Pa. Schuster attended Washington and Jefferson College and for the past five years has been employed in sales work in the Pittsburgh district with Ault & Wilborg Division of Inter-Chemical Corporation. He will be working under the direction of W. R. Persons, who was recently appointed district manager of the Pittsburgh office. The Pittsburgh office also includes H. E. White, J. H. Painter, and M. S. Schonvizner.

THE Lincoln Electric Company, manufacturers of arc welding equipment, Cleveland, Ohio, announces the opening of a welding sales-engineering office at Atlanta, Georgia. The office is located at 412 Title Building and is to be under the management of Robert Daniels.

DEXTER NORTH, chief of the Chemical Division of the United States Tariff Commission, has resigned to become associated with Arthur D. Little, Inc., research chemist and engineers of Cambridge, Mass., as Washington technical representative.

In his new work, North will continue to obtain and assemble technical, economic, and statistical information concerning the chemical and other process industries from the many active sources at Washington. Through his present association, however, similar investigations will be made directly for industrialists, as a part of the technical investigations made by the Little laboratories for clients.

The appointment of North to this post results from the steadily increasing extent to which the Little laboratories have found it necessary to draw upon the technical resources of the many government bureaus, scientific societies, and trade associations whose activities are centered in Washington, as a part of technical investigations for American industrialists and investment bankers.

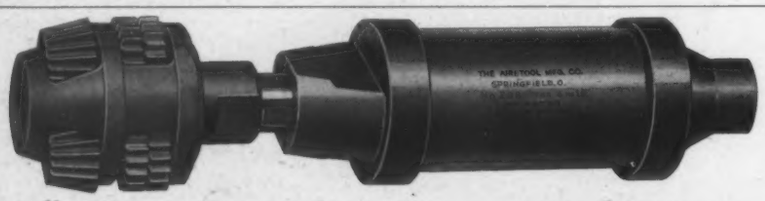
During North's long service with the tariff commission he became thoroughly familar with these resources as a part of his work in directing the gathering of information and the compilation of reports on the competitive aspects of the chemical and related industries, including such phases as raw materials, interprocess and interproduct competition, transportation and marketing, monopolies and tariff considerations. He directed the commission's investigations of the costs of production of petroleum and its products.

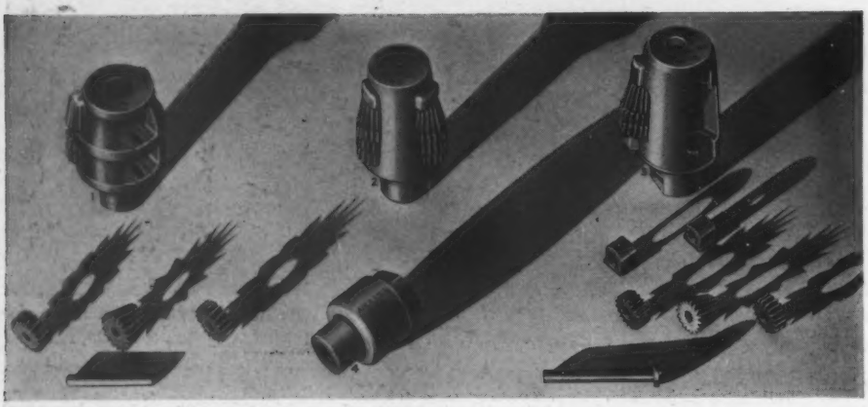
A native of Brookline, Mass., North is a graduate of Hamilton College (1913) and of the Massachusetts Institute of Technology (1916). Since 1921 he has been successively special expert and chief of the chemical division of the tariff commission. He is a son of the late Dr. S. N. D. North, secretary of the National Association of Wool Manufacturers from 1890 to 1903, and director of the census under the administration of Theodore Roosevelt.

PRODUCTION and sales plans for Smith Meter Company, 533 Roosevelt Building, Los Angeles, newly acquired subsidiary of A. O. Smith Corporation, Milwaukee, Wisconsin, are rapidly nearing completion, according to Carl Joys, vice president of the parent organization, and Allan Floyd, general manager of the subsidiary.

"The Smith Meter," said Floyd, "is a highly engineered mechanism for measuring the flow of liquids. As the use of gasoline and other liquid petroleum

CARL JOYS
Vice President, A. O. Smith Corporation





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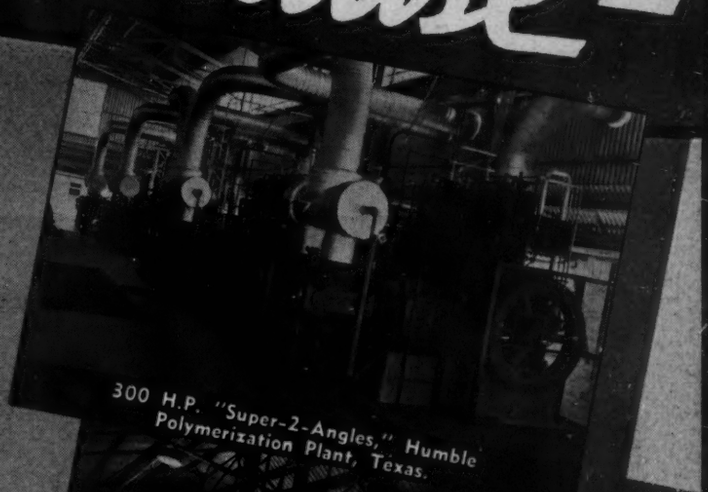
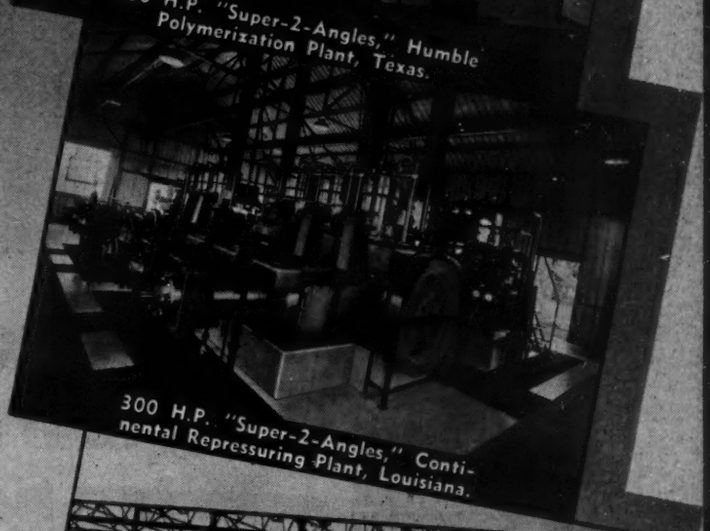


300 H.P. "Super-2-Angles," Humble Polymerization Plant, Texas.



300 H.P. "Super-2-Angles," Continental Repressuring Plant, Louisiana.

600 H.P. "Super-2-Angles," Memphis Natural Gas Co., Arkansas.

600 H.P. "Super-2-Angles," Mississippi Fuel Corp., Louisiana.

products has increased tremendously, so has the problem of quick, accurate measurement become more and more acute. In the old days of the petroleum industry the number of gallons was actually measured by hand, but as the industry speeded up, meters began to be employed. These were largely adaptations of equipment used in other industries and served their purpose well. Our new meter is designed primarily and specifically for the petroleum industry, and to give the speed, and accuracy required under present day circumstances. One of its features is its low resistance to the flow of the liquid being measured. Also, it is practically impossible for either the meter or its indicating device to be tampered with."

These executives then explained that the meter finds many and varied uses throughout the oil industry. It is used for measuring the flow of crude oil and in the refinery for measuring gasoline as well as other liquid petroleum products. At the bulk plant it is used for dispensing to tank trucks; and finally, it is used on the tank trucks themselves, insuring accurate, fair measure in delivery of gasoline to filling stations.

Carl Joys then said, "There is a wide market for this type of meter. We are planning a widespread sales and advertising campaign to the petroleum industry. We are increasing our production schedules and our sales activities."

ALLAN A. FLOOD
General Manager, Smith Meter Company

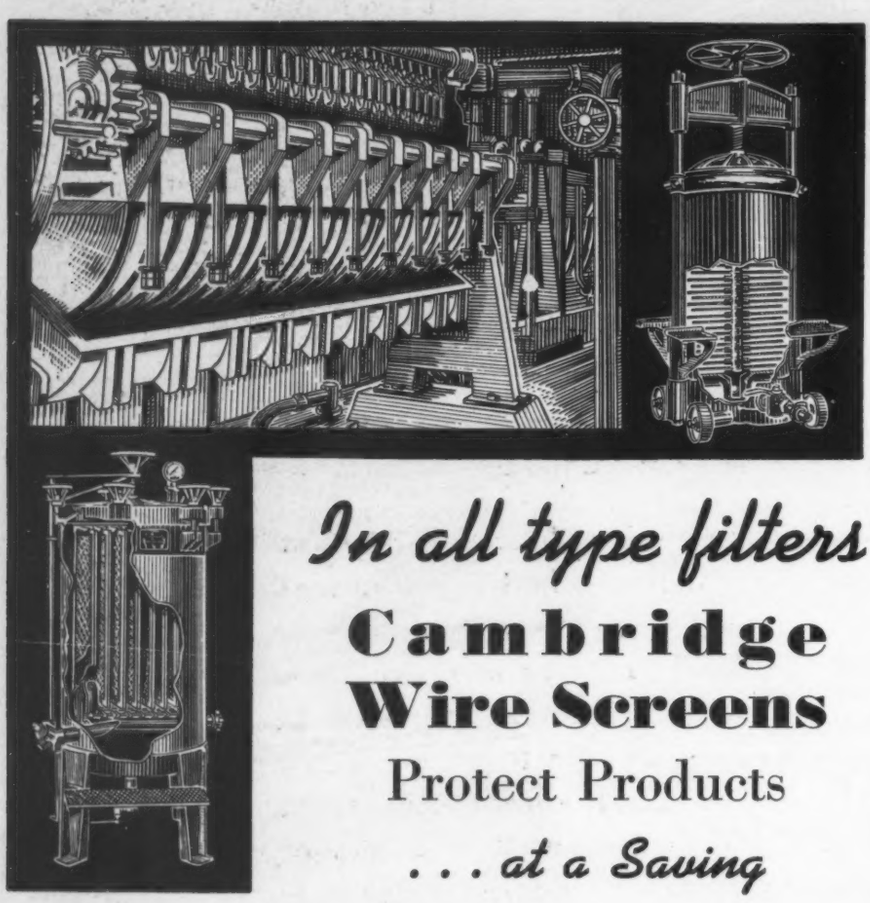
J. W. DUNBAR, formerly in charge of magazine advertising for Incandescent Lamp Department of General Electric Company at Nela Park, Cleveland, has been appointed assistant to C. H. Lang, advertising manager of General Electric Company. Dunbar's headquarters will be at 570 Lexington Avenue, New York, where he will devote his principal attention to the selection of media.

A.S.T.M. Symposium on Corrosion Testing

THE seven technical papers comprising the Symposium on Corrosion Testing Procedures have been issued in the form of a special publication of 131 pages. This symposium was held at the March Regional Meeting of the Society in Chicago and although there was extensive discussion of the papers at the time, the committee in charge felt the subject of such importance that it warranted additional time for further discussion. This was effected through a special session at the annual meeting in New York.

Twelve outstanding authorities prepared the technical papers and many others contributed to the discussion—one-fourth of the volume is devoted to discussion, thus making available in concise form the opinions of other technologists and engineers who have done important work in this field. The symposium covers principles of corrosion testing, atmospheric testing, salt-spray testing, methods for copper alloys, soil corrosion, liquid corrosion and electrical resistance method of determining corrosion rates.

Copies of the publication can be obtained by members at the special prices of 75 cents in paper cover and $1 in cloth. The prices to non-members are $1.25 and $1.50, respectively. The address is 260 S. Broad St., Philadelphia, Penna.



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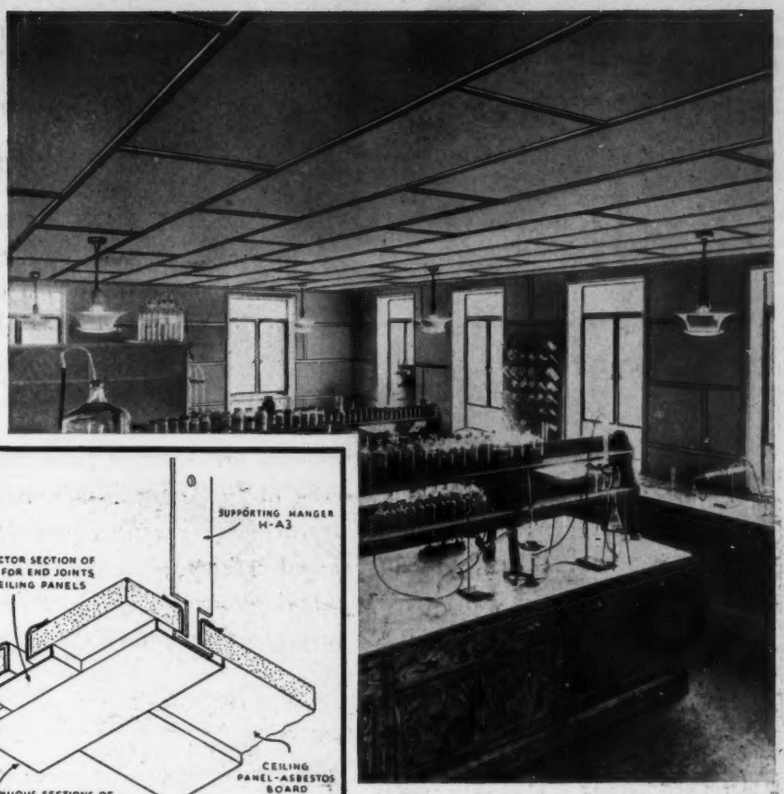

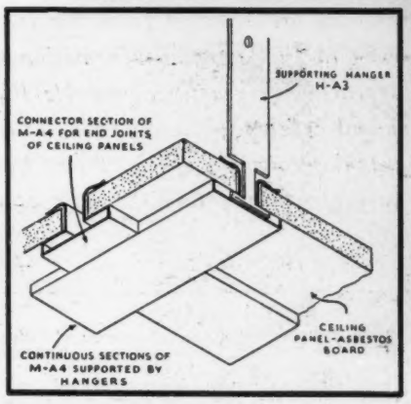
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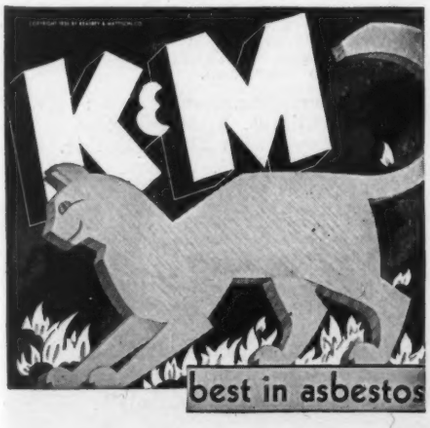

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The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical and Chemical Data

Phase Equilibria in Hydrocarbon Systems. XX. Isobaric Heat Capacity of Gaseous Propane, n-Butane, Isobutane, and n-Pentane. B. H. SAGE, D. C. WEBSTER, AND W. N. LACEY, *Ind. & Eng. Chem.* **29** (1937) pp. 1309-14.

Increasing interest in the thermodynamic data for the paraffin hydrocarbons is noted. The isobaric heat capacity at atmospheric pressure is important in this regard. To add to the few data at present available the authors present the results of their work on the isobaric heat capacities at atmospheric pressure of gaseous propane, n-butane, isobutane, and n-pentane at temperatures from 90° to 320°F. The data secured in their work are compared with the data of other investigators. The apparatus used in securing the data is described as well as the manner of interpreting the data and making the calculations.

Thermodynamics in Hydrocarbon Research. C. L. THOMAS, G. EGLOFF, AND J. C. MORRELL, *Ind. & Eng. Chem.* **29** (1937) pp.1260-7.

Thermodynamic calculations are most useful to the research worker in hydrocarbon chemistry in helping him to decide whether the reaction may occur to a usable extent, and what temperature range is favorable for the reaction. Having answers to these questions, it remains for the investigator to find a suitable catalyst to accelerate the rate of the desired reaction to the practical exclusion of undesirable reactions. The authors discuss the differences between thermodynamic data calculated from low-temperature heat capacities and those from infrared and Raman spectra. Available thermodynamic data from the literature have been assembled for the hydrocarbons, and are presented. New equations for the free energies of paraffins and olefin hydrocarbons are given. The equation for the olefins leads to the conclusion that all olefins whose free-energy temperature relations are expressed by the equation, have a constant standard free energy of formation per carbon atom of 9147 calories at 611°K. Such olefins should therefore be interconvertible at this temperature with a zero standard free-energy change in the presence of a suitable catalyst. Examples of the application of thermodynamic data to specific problems are given.

Infrared Absorption of Nineteen Hydrocarbons Including Ten of High Molecular Weight. F. W. ROSE, JR., *J. Res. Natl. Bureau Standards* **19** (1937) pp. 143-61.

The infrared absorption spectra of the following hydrocarbons were measured with a recording infrared glass spectograph between 5400 and 8900 cm.$^{-1}$ (1.82-1.12 u) and the molecular absorptive indices plotted against wave numbers: 2-, 3-, 4- and 5-methylnonane, PrPh, isopropylbenzene, 3, 5, 5-trimethylheptane, 3, 4. 5, 5-tetramethylhexane, ethylcyclohexane, phenyloctadecane, cyclohexyloctadecane, 5-cyclohexyldocosane, (7-tetrahydronaphthyl) octadecane, 5- (7-tetrahydronaphthyl) docosane, 5-(7-tetrahydronaphthyl)-5-docosene, 5 - (2-decahydronaphthyl) docosane, (p-diphenyl) octadecane, 1-(p-diphenyl)-5-docosene.

Collected Results on Viscosity of Lubricants Under Pressure. I. Fatty Oils. M. D. HERSEY AND R. F. HOPKINS, *J. Applied Phys.* **8** (1937) p. 560.

Reported results on the viscosity of castor, lard, rapeseed, sperm, camellia-seed, hemp, horse and whale oils are presented in tabular form in such a way that they can be easily graphed. The suggested form of graphing is to plot values of Z/Z_1 (Z=viscosity at p atm., Z_1=viscosity at 1 atm.) against p to give lines for various temperatures, and to plot Z_1/Z_0 (Z_1=viscosity at t°C., 1 atm., Z_0=viscosity at 25°C. and 1 atm.) against t. From these curves and a value for Z_0 the complete behavior of the oil can be determined.

Chemical Compositions and Reactions

The Dehydrogenation of Hydroaromatic Hydrocarbons with an Alkyl Disulfide. J. J. RITTER AND E. D. SHARPE, *Jour. Am. Chem. Soc.* **59** (1937) pp. 2351-2.

Previous chemical methods for the dehydrogenation of hydroaromatic substances have been limited principally to the well known sulfur and selenium treatments. Dehydrogenation with an alkyl disulfide has been accomplished by the authors and used in the conversion of tetralin to naphthalene and of ionene to 1, 6-dimethylnaphthalene.

Studies in Gaseous Polymerizations. J. B. HARKNESS, G. B. KISTIAKOWSKY AND W. H. MEARS, *J. Chem. Phys.* **5** (1937) pp. 682-94.

A number of hydrocarbon associations were studied in the gas phase and their rate constants determined in cc. per mole per second. Dimerizations of styrene, vinyl acetylene, chloroprene, vinyl acetate and allene were attempted, but the behaviours of these substances made them unsuitable for kinetic studies of this type below atmospheric pressure. The dimerization of cyclopentadiene in the pure liquid phase was studied and the rates determined. The kinetics of the gas-phase polymerizations and the Diels-Adler condensations are discussed; they occur through the mechanism of free radicals.

Kinetics of Catalyzed Polymerization of Styrene. G. WILLIAMS, *Nature* **140** (1937) pp. 363-4.

Using carefully purified materials, the half-conversion period for the polymerization of styrene in carbon tetrachloride and chloroform solution catalyzed by anhydrous $SnCl_4$ at 25°C., is about 1 hour. Using up to 1.73 M styrene in CCl_4, and commercial c.p. $SnCl_4$, 0.01-0.02M, a totally inhibited period of 0.6-4.2 hours preceded the polymerization, which had a half conversion period of 1-8 hours. Water retards polymerization; dry HCl is a temporary complete inhibitor. The inhibition results from the saturation of the double bonds of the styrene. The styrene monomer was determined (±0.5%) by brominating the double bond, and then determining the excess bromine.

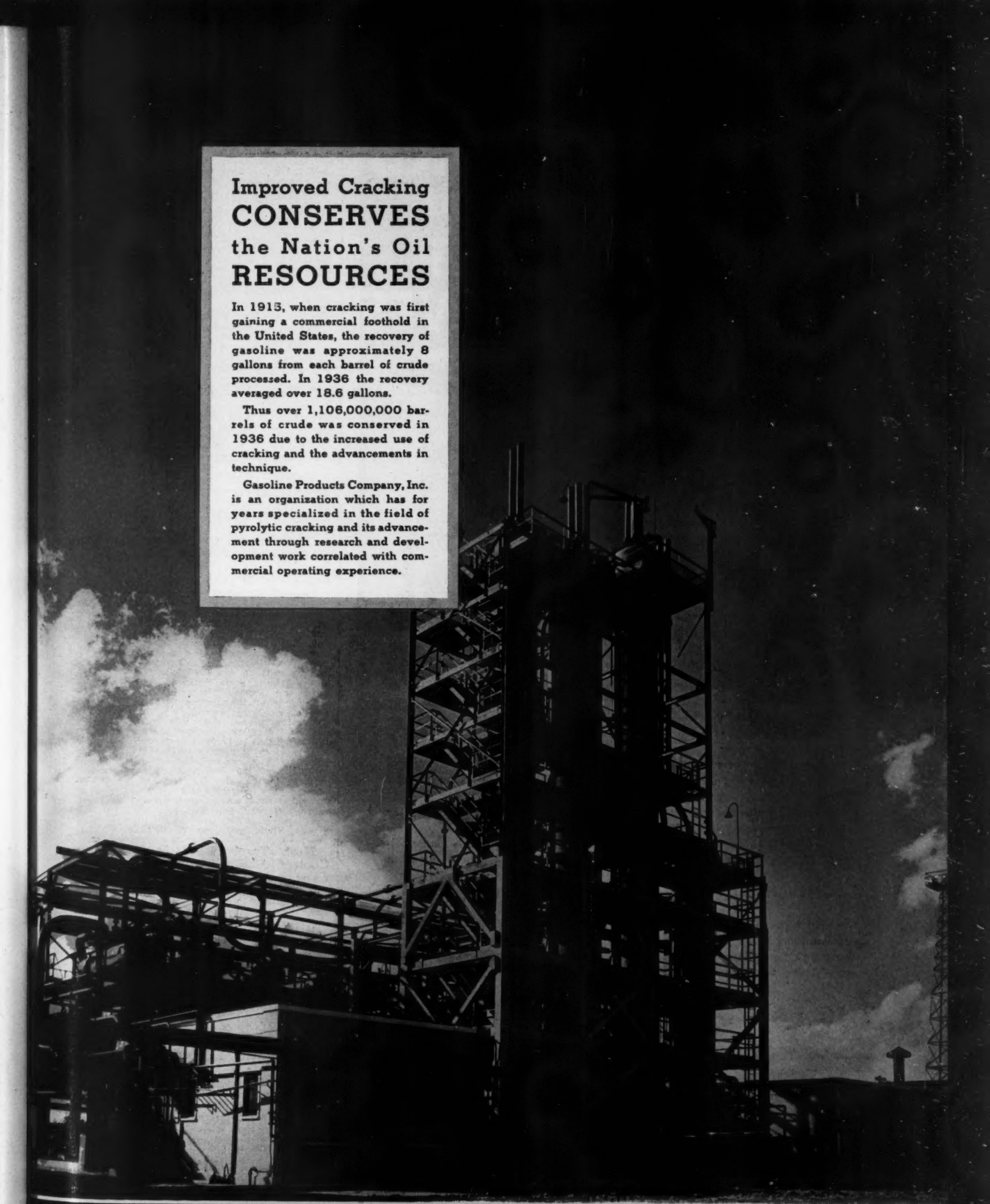
The Rearrangement of Acetylenes into Allenes at High Temperature. C. D. HURD AND R. E. CHRIST, *Jour. Am. Chem. Soc.* **59** (1937) pp. 2161-5.

1-Hexyne and 1-heptyne were treated thermally at temperatures of 500, 550, and 600°C. The chief gaseous products were propylene, methane and ethylene, but some ethane and hydrogen were also formed. By ozonolysis it was established that the liquid products from 1-hexyne contained 1, 2-hexadiene, and that the liquids from 1-heptyne contained 1, 2-heptadiene. Except in the experiment at 600°C. there was no evidence of the production of 2-alkynes, and then only in traces. Aromatic hydrocarbons or 1, 3-alkadienes were not formed. Similarly, in the work with 1-butyne at 560°, the absence of 1, 3-butadiene was established. The rearrangement of 1-alkynes into 1, 2-alkadienes does not proceed at 400°, but requires temperatures that are high enough to cause concurrent breakdown into gaseous products. The significance of this fact is brought out in the reaction mechanism.

Nitrogen Compounds from Petroleum Distillates. X. Purification of Nitrogen Bases with Zinc Chloride. R. I. MAHAN AND J. R. BAILEY, *Jour. Am. Chem. Soc.* **59** (1937) pp. 2449-50.

In the course of a study of the nitrogen compounds from petroleum distillates it became important to have at hand a method for the purification of the nitrogen bases. A simple and economical procedure involving the use of zinc chloride is described. The process includes, in one operation, the removal of water hydrocarbons, thio- and phenolic bodies, and other associated non-basis contaminants. Zinc chloride can be recovered and re-used.

The Hydroxylation of Unsaturated Substances. IV. The Catalytic Hydro-



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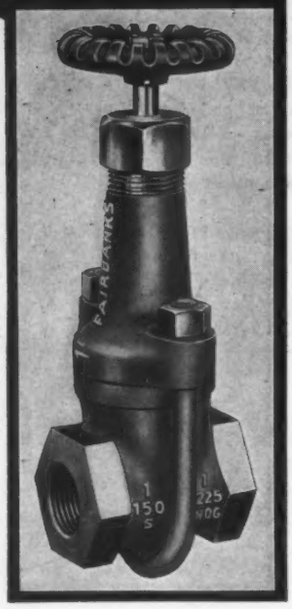

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The double-taper slide-on wedge cuts through heavy fluids and sediment. No possibility of foreign matter plugging up valve or preventing seating.

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xylation of Unsaturated Hydrocarbons. N. A. MILAS AND S. SUSSMAN, *Jour. Am. Chem. Soc.* **59** (1937) pp. 2345-7.

Unsaturated hydrocarbons can be hydroxylated by means of hydrogen peroxide in anhydrous tertiary butyl alcohol and in the presence of osmium tetroxide. An apparatus for the quantitative hydroxylation of unsaturated gaseous hydrocarbons is described. Ethylene glycol was prepared from ethylene; propylene glycol from propylene; cetene glycol from cetene; phenyl glycol from styrene; Pentanediol-2, 3 from pentene-2; 2-methylbutanediol-1, 2 from 2-methylbutene-1; hexanediol-3, 4 from hexene-3; cis-cuclohexanediol-1, 2 from cyclohexene; hexanetetrol-1, 2, 5, 6 from diallyl; and phenol from benzene.

Fluorinated Derivatives of Propane. A. L. HENNE AND M. W. RENOLL, *Jour. Am. Chem. Soc.* **59** (1937) pp. 2434-6.

Extending previous work by themselves on the fluorine derivatives of methane and ethane the authors report on the preparation of new fluorinated derivatives of propane and upon the physical properties of these substances. The influence of a CF_2 group in the middle of the molecule has been examined and its stabilizing effect emphasized. The physiological enigma of a compounds stabilized by the presence of a CF_2 group is well illustrated by the fact that animals can be kept for hours in an atmosphere of 20 volumes of oxygen and 80 volumes of $CH_3CF_2CH_3$ and yet show no signs of discomfort, and no delayed effect.

Manufacture: Processes and Plant

Heat Transfer Coefficients in Falling Film Heaters. Streamline Flow. G. S. BAYS, JR. AND W. H. MCADAMS, *Ind. & Eng. Chem.* **29** (1937) pp. 1240-6.

Attention is called to the relatively high liquid-side heat transfer coefficients that can be obtained by applying the falling film principle to the heating of viscous liquids. The purpose of the investigation was to measure the magnitude of the individual liquid-side coefficients of heat transfer obtainable in the heating of various liquids falling in a layer down vertical heating surfaces, and to determine the relation between these coefficients, the physical properties and rates of flow of the fluid, and the dimensions of the heating surfaces. Two viscous oil and water were used as the fluids. The physical properties of the oils are given in detail. New data are presented for the streamline flow of oils in layer form down the inner walls of vertical tubes ranging in length from 0.4 to 6.0 feet. The Reynolds number ranged from 2 to 2000, and the coefficients of heat transfer, from 40 to 140. The data obtained, as well as data in the literature for water flowing in streamline motion over three sizes of horizontal tubes, with coefficients ranging from 540 to 915, were correlated in terms of the dimensionless groups, hB/k, $\mu w/\mu$, and $CpB\Gamma/kL$.

Heat Transmission in Film-Type Coolers. A. K. G. THOMSON, *Jour. Soc. Chem. Ind.* **56** (1937) pp. 380T-384T.

The film type cooler comprising a bank of horizontal tubes connected by headers at each end, the liquid to be cooled passing through the inside of the tube and the water flowing over the outside of the tube, finds extensive application in refrigeration work and in the dairy industries. This type of cooler or condenser has the advantage of a high coefficient of heat transfer and low water consumption. The outside film resistance, that is, between the wall of the tubes and the water trickling over them, was the subject of the reported investigation. The apparatus used in the work is described in some detail, and the experimental data recorded in forty-eight runs are given. It was found that the film coefficient increases with water film thickness and water rates. The relationships are presented in graphical form.

Automatic Control and the Chemical Industries. L. DEFLOREZ, *Ind. & Eng. Chem.* **29** (1937) pp. 1210-13.

The broad fundamentals of automatic control are discussed. The purpose of automatic control is to conduct processing procedures with greater accuracy and reliability than is manually possible and with consequent improvement of product, and reduction in unit cost. In any given process it is important to determine the key variable about which the control procedure can be built. Determination of this variable is the function of those skilled in the particular process. This information must in turn be imparted to those who are expert in the mechan-

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ical equipment of control. The control of a cracking plant, and the control of aircraft in flight are cited as examples in discussing the fundamentals of the development of control procedure.

Elements of Automatic Control. J. J. GREBE, *Ind. & Eng. Chem.* **29** (1937) pp. 1225-28.

Common experience is cited to illustrate the problems met in connection with automatic control, and the principles of operation used in automatic control. As an example for illustrative purposes, the continuous neutralization of an acid by an alkali is selected. The various kinds of time lag encountered are indicated. These are capacity lag, transfer lag, and head lag. The latter is resolved into the first two. Four basic elements of control are derived—metered control, deviation control, rate control, and damping control. These are illustrated by various kinds of automatic control equipment. A direct appraisal of the performance of control equipment is given by determining the time required to reestablish equilibrium in terms of the transfer time lag. A control that will reestablish equilibrium in twice the time lag is considered satisfactory.

Control of Liquid Level in Vessels Under Pressure. J. B. MCMAHON, *Ind. & Eng. Chem.* **29** (1937) pp. 1219-24.

A classification of types of liquid level controllers is given, and the operation and limitations of each type are discussed, particularly with reference to their application to continuous processes. Averaging level control, which is a comparatively recent development, is discussed in some detail. A questionnaire is given outlining the factors that must be taken into account in applying an averaging level controller, using a ball float as the measuring element.

Continuous Control Systems with Variable Characteristics. H. M. SCHMITT, *Ind. & Eng. Chem.* **29** (1937) pp. 1229-31.

Three automatic control systems are described. Two of these are particularly applicable to electrical methods of temperature measurement and control in which thermocouples, resistance thermometers, or photoelectric cells are used as the measuring element, and motor-operated valves are employed to regulate the control medium. The third covers a pneumatic method for regulating the controlled medium in response to changes in temperature, pressure, flow, or liquid level. All three of these systems incorporate means for adjusting the throttling range and rate of automatic reset while the instruments are in operation. These characteristics result in automatic control systems adaptable to processes different in nature and operating conditions.

Automatic Mixing and Proportioning of Gases and Liquids. H. J. VELTEN, *Ind. & Eng. Chem.* **29** (1937) pp. 1214-18.

The perfect maintenance of volumetrically proportioned flows and accurate mixing must be based on correct metering of the individual flows. Several proportioning and mixing problems are described as they have been solved, and actual installations are illustrated and discussed as they have been made in different industries. New metering devices are described that have been developed for the purpose of automatic proportioning of gases and liquids. Special attention is devoted to the automatic proportioning over ranges wider than are obtainable with ordinary flow metering devices commonly used in industrial application. The tendency towards greater flowmetering ranges necessitates further research and development work that can most profitably be furthered by the cooperation of manufacturers and operating engineers in the industries.

A Suction Pyrometer for the Determination of Gas Temperatures up to 2000° F. E. A. C. CHAMBERLAIN, *Jour. Soc. Chem. Ind.* **56** (1937) pp. 395T-6T.

Although the theory and use of the suction pyrometer of high-velocity thermocouple for the accurate measurement of gas temperatures are well known, the author notes that the actual construction of the instrument has not been fully described. A practical form of the instrument was developed involving the following features: (1) general utility for measuring gas temperatures up to 2000°F.; (2) an easily replaced immersion tube of refractory material to carry the couple leads; (3) the suction head provided with cooling fins to prevent overheating; (4) thermocouple leads having an electrically insulated, gas-tight joint at the point

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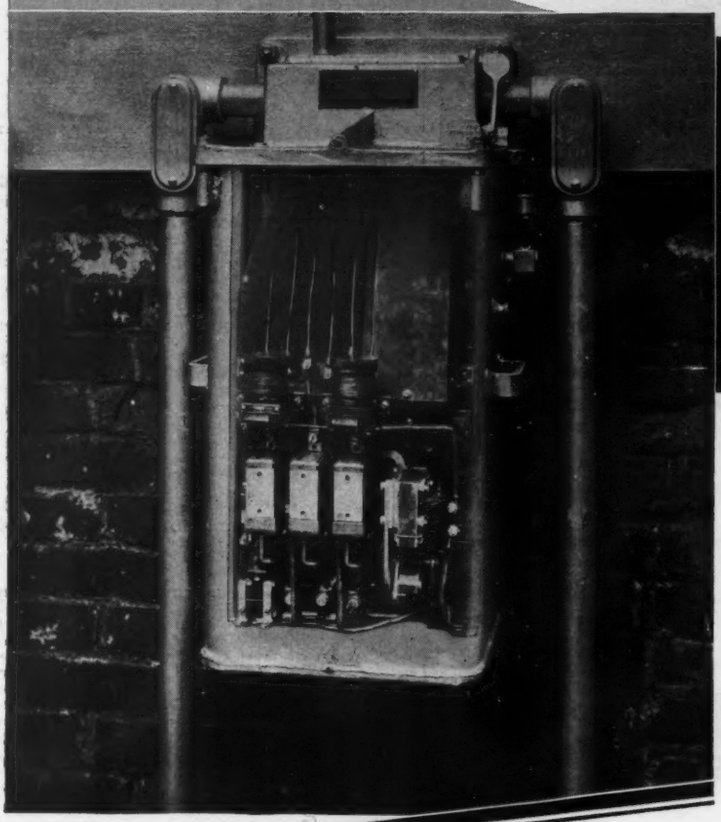

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from which they emerge from the suction head. A suitable suction device is also described. For most purposes a suction velocity of 50 feet per second is sufficient, but occasionally where the radiating effect of the enclosed walls is very large a greater velocity than this may be found necessary.

The Treatment of Burns with Tannic Acid. G. GHEESLING, *Ind. Med.* **6** (1937) p. 306.

In the treatment of burns morphine or codeine, in saline-glucose solution, should be given for shock. The skin should be cleaned with ether or benzine and blisters opened. A 5% tannic acid solution should be sprayed on the burned area every 15 to 30 minutes until a suitable tan develops.

Toxic Accidents by Carbon Tetrachloride Resulting from Its Use as a Fire Extinguisher. R. DE GAULEJAC AND P. DERVILLEE, *Ann. Med. Legale Criminol. Police Sci.* **17** (1937) pp. 366-79.

The authors review and discuss conditions under which accidents have been known to occur as a result of the use of carbon tetrachloride in fire extinguishers. Preventive and remedial measures are considered.

Petroleum and Natural Gas Bibliography. R. E. HARDWICKE, *University of Texas, Austin.* 1937.

This bibliography is a book comprising 167 pages with 1397 references and an author index at the end. General headings cover all aspects of petroleum and natural gas including books only. Periodical references are excluded, as well as patent literature, but a section is included on catalogues, indexes and abstracts. Technical, economic, legal and general aspects of the subject are covered.

Products: Properties and Utilization

Research in Relation to the Motor Vehicle—Fuels and Lubricants. F. H. GARNER, *Jour. Inst. Pet. Tech.* **23** (1937) pp. 575-601.

The importance of active cooperation between engine and fuel manufacturers is emphasized. The characteristics of fuel, depending upon volatility are first discussed. This includes ease of starting, absence of vapor lock, rapid warming-up, satisfactory acceleration and idling, freedom from dilution, and economy as respects fuel consumption. The author next notes the fact that for heavy commercial transport the compression-ignition engine is rapidly assuming the predominant position as compared with the gasoline engine in England, and in France and Germany that long distance commercial transports and omnibusses are almost entirely operated by compression-ignition engine vehicles. The characteristics of these fuels and the trend of development in their characteristics and use are discussed. Engine lubricating oils are then considered in relation to ease of starting in cold weather, satisfactory lubrication of the engine, which includes relative freedom from deteriorat'on in use, freedom from sludge formation, and the formation of carbon in the engine, and no harmful action on the bearings or any other parts of the engine, and lastly, minimum oil consumption consistent with adequate lubrication. Testing of oils to determine their fitness in these various directions is briefly reviewed. The discussion of the articles by others is of considerable interest in connection with the various subjects.

Petroleum Wax: Determination, Analysis, and Conclusions About Its Composition. D. S. MCKITTRICK, H. J. HENRIQUES AND H. I. WOLFF, *Jour. Inst. Pet. Tech.* **23** (1937) pp. 616-27.

A method of determining the wax content of oil and the oil content of wax has been developed. This appears to be more accurate and reproducible and of wider applicability than any previously described methods. The wax is crystallized from ethylene dichloride at —35°C. or from chloroform at —55°C. The determination of melting-point and refractive index distributions of the d fferent waxes in a mixture, separated by stepwise crystallization at successively lower temperatures, is a useful way of characterizing the wax. Low-melting waxes that must be removed to produce oils of low pour-point, have been found in oils together with the expected high-melting ones. High-melting fractions of d stillate waxes contain large proportions of normal paraffins. In frac-

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tions with successively lower melting points, isoparaffins, napthenes, and probably also aromatics, in that order, may predominate. The higher-melting fractions of residue waxes are not largely normal paraffins, but contain large proportions of hydrocarbons of other series. Although American crudes, Eastern, Mid-Continent and Western, differ considerably in chemical types, the compositions of the waxes from the distillates from these three crudes are similar. The waxes from the residual oils, however, differ, showing characteristics related to those of the parent crudes. Petrolatums have been shown to be mixtures of moderately hard waxes with oils of low pour-point. A table six pages in length gives the properties of pure hydrocarbons as recorded in the literature. The properties included are: melting point, boiling point, density, refractive index, and structure.

The Determination of the Ignitability of Diesel Oils on a Laboratory Scale, R. HEINZE AND M. MARDER, *Jour. Inst. Pet. Tech.* **23** (1937) pp. 602-15.

It is noticed that in several recently published articles the reliability of the laboratory method of determining the ignitability of Diesel oils has been questioned. In spite of this the authors state that they have proved that by the proper application of the parachor or density method cetene values comparable with those determined by engine tests are obtained. Standard as well as sub-standard testing oils, and also diesel oils of any origin, as for instance from crudes, lignite tar, coal tar or those manufactured by hydrogenation, by synthesis or by extraction, give the same cetene numbers as determined by the engine test. Other constants can also be used to indicate the value of diesel oils, as, for example, the diesel index, the ring-analysis value, the calorific value, the hydrogen and carbon content, the ratio of carbon and hydrogen, and the Siedekennziffer of W. Ostwald. The density method for the determination of the cetene value is the simplest laboratory test. This is effected through the use of the so-called "cetene value aerometer." On the scale of this instrument the cetene values of the oils under investigation are directly indicated, subject to a correction for the Siedekennziffer.

Carbonization of Lubricating Oils. H. N. BASSETT, *Engineer* **164** (1937) p. 176.

Methods for determining the tendency of lubricating oils to carbonize in an engine may be grouped into coking tests, oxidation tests and volatility tests. Coking tests do not adequately indicate the behaviour of the oil in the engine in relation to carbon deposition. Oxidation tests are satisfactory only in evaluating straight distillates, and fail when oils are blended with residual cylinder stocks. The carbonization index, i.e., the temperature at which 90% of the oil is distilled off under 1 mm. absolute pressure, is considered to give a fair indication of the behavior of the oil under working conditions, provided the oil is not one that cracks readily. The general subject of the correlation of specific examples of coking, oxidation and volatility tests with performance is considered.

Tropical Structure of the Oil Molecule, Polymerization and Film Formation, B. SCHEIFELE, *Kolloid-Z* **80** (1937) pp. 219-20.

Polyp-like space models of the triglyceride molecules were made in order to explain the polymerization, film formation and spreading of these oils. In these models the 3 long fatty acid chains, emanating from the glycerol portion, stick out into space like the arms of polyp, and they can rotate freely in the 3-space dimensions.

Determination of Butenes in Refinery Gases, W. A. MCMILLAN, *Ind. & Eng. Chem., Anal, Ed.* **9** (1937) pp. 511-14.

The unreliability of present methods for the determination of butenes is reviewed. A new method is presented for the determination of individual components normally occurring in refinery and cracked petroleum gasolines. By its use, the individual four-carbon hydrocarbons, with the exception of the individual isomeric 2-butenes, can be determined within an accuracy of better than $\pm$ 0.15%. Gas samples of the size used now for low-temperature fractional distillation are required. A new gas-reaction analytical method for the determination of isobutene with anhydrous hydrogen chloride has been developed as a part of the general scheme of analysis. This allows the determination of isobutene in the presence of any other normally gaseous olefin with an accuracy of

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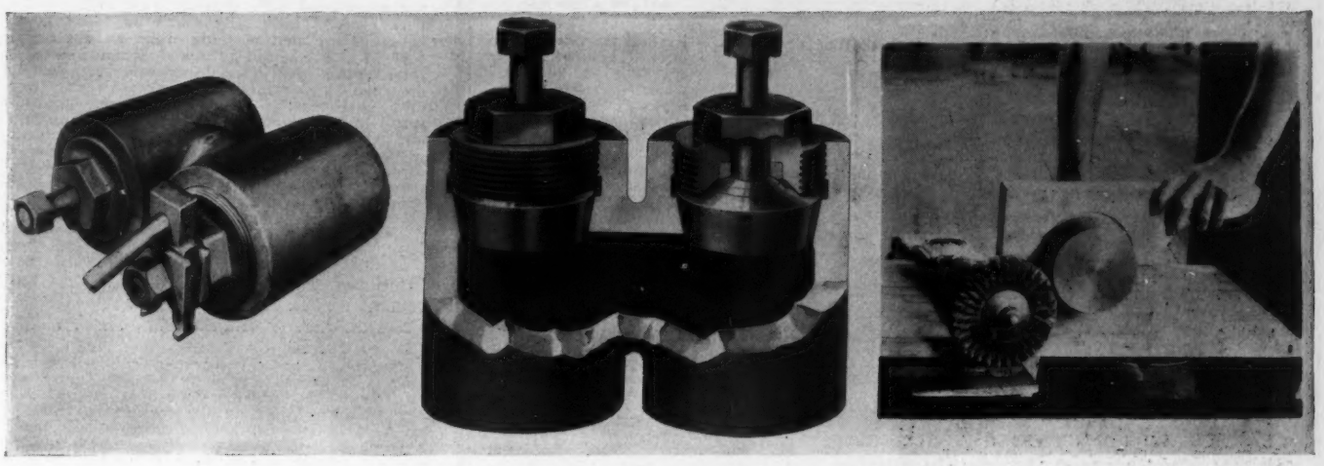

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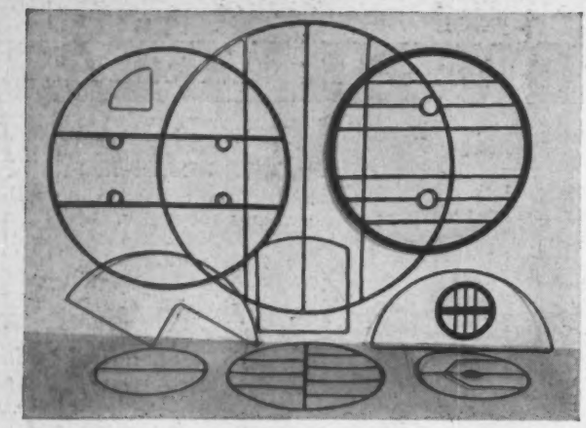

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0.1 percent. The apparatus is described, and typical results are given.

The Kauri Butanol Test for Solvent Power. II., E. L. BALDESCHWIELER, M. D. MORGAN, AND W. J. TROELLER, *Ind. & Eng. Chem., Anal. Ed.* **9** (1937) pp. 540-3.

The kauri butanol solvent power or the amount of a given solvent that can be added to a standard kauri gum solution in butanol to produce a definite turbidity, as compared with the amount of C.P. benzene used in a similar titration and arbitrarily taken as 100 percent is suggested as being useful as an additional tool in the analysis of hydrocarbon mixtures. Micromethod for determining solvent power is described. Using this method the solvent power of typical paraffin, olefin, naphthene, and aromatic hydrocarbons was determined. These data are presented in some detail. Given the solvent power of the first member of a hydrocarbon series it is possible to calculate the solvent power of the other hydrocarbons in the same series. Conversely, the solvent power of an unknown hydrocarbon gives a clue to its composition and structure.

Electrometric Titration of Acids in Oxidized Petroleum Oils, A. R. RESCORLA, F. L. CARNAHAN, AND M. R. FENSKE, *Ind. & Eng. Chem., Anal. Ed.* **9** (1937) pp. 505-8.

The weak acids present in oxidized petroleum oils are titrated only with difficulty by most methods. In the investigation reported attention was given to the selection of a suitable electrode pair, an indicating device, and a base, and it was especially necessary to develop a nonaqueous mixture of proper solvent and conducting power for use with oxidized oils. The apparatus comprised a pair of tungsten-platinum electrodes, together with a device for amplifying and indicating the small current furnished by the electrode. The oil under examination was dissolved in a mixture consisting of equal parts by volume of isoamyl alcohol, benzene, and carbon tetrachloride saturated with lithium chloride. The base used was prepared by dissolving metallic sodium in isoamyl alcohol. Utilization numbers can be checked on duplicate samples within 0.2 percent by the electrometric method. The apparatus is described, and data secured with its use are given.

A Modification of the A. S. T. M. Lamp Sulfur Method for Refined Kerosenes, E. FIELD AND F. H. DEMPSTER, *Ind. & Eng. Chem., Anal. Ed.* **9** (1937) pp. 547-50.

The lamp method for the determination of sulfur in refined kerosenes has been found to be inaccurate if the amount of sulfur is less than 0.01 percent. The lamp method has been modified to obtain a much greater degree of accuracy, not only for the analysis of kerosene but also of other refined oils for which the A.S.T.M. lamp method is suitable. Data given show that it is essential to use purified air during the burning, a larger weight of the sample must be burned, hydrogen peroxide is to be preferred as an absorbing medium, and if accurate, reliable results are to be secured, the total sulfur after absorption must be determined by gravimetric means. The proposed apparatus is described in detail.

Determination of Small Proportions of Sulfur by a Modification of the A. S. T. M. Lamp Method, V. ZAHN, *Ind. & Eng. Chem., Anal. Ed.* **9** (1937) pp. 543-7.

Refinements of the standard lamp method for the determination of sulfur are described. These extend the usefulness of the method to analyses of the substances containing as little as 0.0001 percent of sulfur, either in liquids or gases. The A.S.T.M. lamp method is subject to large errors when the material being analyzed contains larger than 0.01 percent of sulfur. The two important sources of error are impurities in the large volume of air required for combustion, and acids, such as nitric acid, formed through the oxidation of atmospheric nitrogen. By using purified air for combustion, and estimating the sulfur turbidimetrically, high accuracy and reproducibility is secured. The apparatus is described in detail, and typical results are given.

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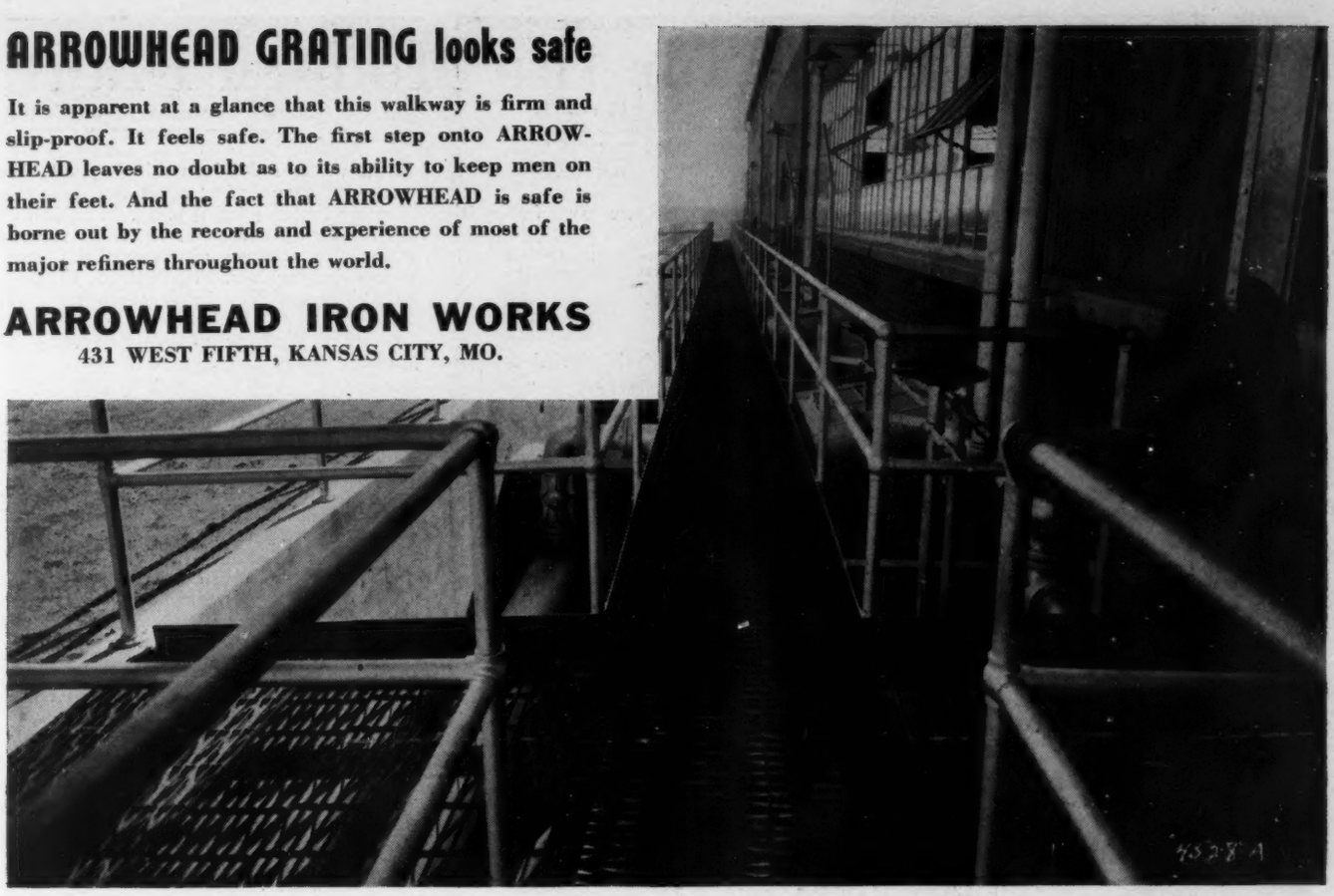

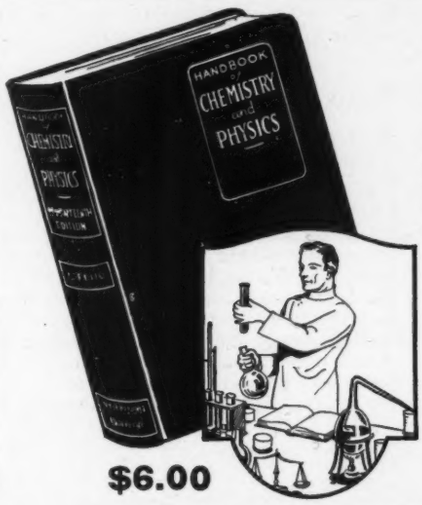

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The new holder, designated "Type ST," weighs only 14 ounces and has a current capacity of 250 amperes continuous, equalling that of many type holders weighing 25 ounces or over. The light weight, obtained without any sacrifice of capacity, is attributed to use of formed steel parts, electrically welded.

Lincoln Electrode Holder

Unique for its light weight, the new holder has a number of other advanced features, most important of which is probably the extremely simple type of connection which assures positive contact and eliminates loose connections, a more or less common cause of overheating in holders.

To assure permanence of connections, all contacts are electrically welded. Connection to cable is provided by a special, easily operated clamp which locks the cable to the electrode holder. The clamp can be tightened or loosened without tools, by inserting a welding electrode through hole in square head of the clamp cap screw and applying leverage. (Patent applied for.) When tightened, this clamp maintains positive contact with the flat-braided flexible copper strip which carries current to the jaws. The result is a complete copper low-resistant circuit direct from the welding machine through the holder to the electrode.

Other important features of the new holder, in addition to light weight and easy connectibility, are: reduced overall width, permitting easier welding in corners and other confined places; rounded rather than square corners at important points to lessen the likelihood of contacting the holder and causing arcing; use of heavier copper jaws to assure maximum conductivity and prevent sticking of the electrode to the holder; grooving of the jaws for vertical and overhead as well as flat welding; a hollow fibre handle, correctly proportioned to fit the the user's hand and afford a positive grip; fully insulated thumb lever and non-groundable sturdy spring.

The "Type ST" holder will accommodate any size electrode up to and including ¼-inch.

Remote Measurement

THE BROWN INSTRUMENT COMPANY

The Brown Instrument Company, Philadelphia, announces development of pneumatic remote transmission of measurement, which is designated as a Pneumatic Transmission for Remote Measurement with Air-Operated Control. It is entirely new, yet safe and a dependable system, the makers claim. It is designed primarily for remote measurement of process variables in atmospheres containing explosive gases. It consists essentially of a transmitting-indicating instrument, at the point of operation and a receiver which may be an indicator or recorder, located at the remote master control board. The remote transmission unit is a simple, balanced air pilot, mechanically actuated and built into the indicating transmitter. The receiver is either an indicating or recording pressure gauge, calibrated in terms of the variables being measured. There are only a few working parts which are simple in construction. Where accidental damage may occur, repairs can be made easily and quickly in the field without special tools. Recalibration or compensation is not necessary whenever a transmission line is lengthened or shortened. A definite pressure response for less than 0.1 percent of full scale movement indicates the sensitivity of the device. The balanced pilot system of the transmitter unit stabilizes the mechanism so that it can not over shoot. Speed is indicated by the fact that 1 percent change in the metered value will be transmitted 200 feet in less than 1 second with full scale change in approximately 20 seconds. The element in the receiver develops a high pen torque for small changes in transmitted pressures. The air consumption is only .016 cubic foot of free air per minute. Readings are not affected by ordinary vibration at the transmitter and receiver. The Ambient temperature change of 60 degrees affects the readings less than 0.25 percent. The devices operate dependably at sub-zero temperatures.

Hex-Box Wrenches

J. H. WILLIAMS & CO.

J. H. Williams & Co., 75 Spring Street, New York City, announces new heavy duty pattern hex-wrenches designed for severe service, and to provide extra strength and full bearing the heads are approximately the same thickness as the nuts they serve. Their

Williams Hex-Box Wrench

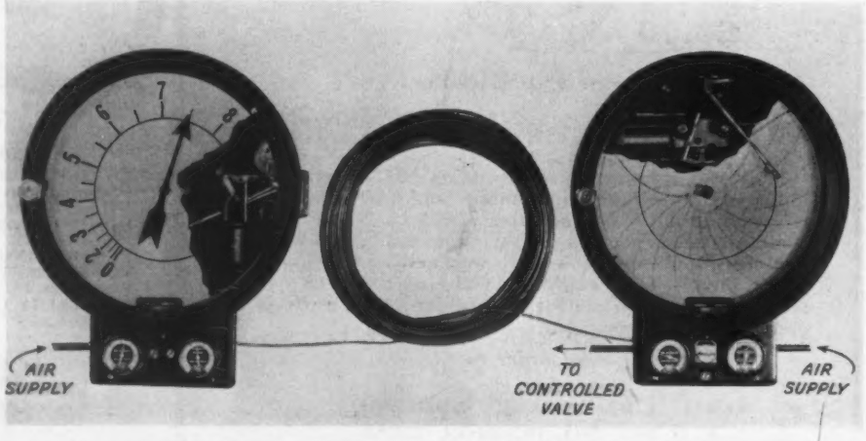
comparatively thin head walls are particularly efficient in close quarters. Openings range from 1¼ to 3⅛ inches. Drop-forged in 2 lines—carbon steel wrenches and chrome-molybdenum "Superrenches."

Carbon wrenches are finished in black enamel (baked-on) with bright heads. "Superrenches" are chrome-plated with the faces of heads buffed bright.

Pumping Unit

WORTHINGTON PUMP & MACHINERY CORPORATION

Worthington Pump and Machinery Corporation, Harrison, New Jersey, announces a new compact pumping unit for bulk transfer service where both thin and highly-viscous liquids are handled. The pump is of the herringbone-gear-impeller type driven by a constant-speed motor or internal-combustion engine through a two-speed, enclosed transmission. For light liquids, the pump may be operated at high speed, while for viscous liquids the speed of the pump



Assembly of Brown Pneumatic Flow Transmitting System

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The relative toughness of steel at low temperatures is an important factor in its selection for equipment used in dewaxing plants. The performance of pumps, centrifuges and similar equipment can be considerably affected by the sub-zero impact strength of the steel in highly stressed parts.

Molybdenum steels, when properly heat-treated, have excellent impact properties at low temperatures. Investigation shows that they retain their toughness very well even at temperatures as low as –90° F.

They offer great possibilities to the maker of dewaxing equipment. Advantage can be taken of their established price and fabricating economy with perfect assurance of their performance.

We will be glad to send detailed information on the low-temperature impact properties of several well-known Molybdenum steels to any one interested. Climax Molybdenum Company, 500 Fifth Avenue, New York City.

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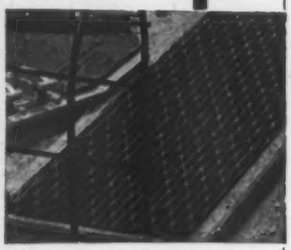

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may be reduced. In either case, the full power of the prime mover is employed.

In conventional applications of single pumping units on such service, motors are selected for the heaviest loads and are operated at a fraction of their rated power when pumping the thinner liquids. The new two-speed unit affords maximum efficiency because a relatively small constant-speed driver is used.

The manufacturer states that various applications of these units have proved satisfactory, due to the self-priming high-suction qualities and positive displacement features in the pump. There are no valves to retard the liquid flow, and the entire unit requires little space.

Pressure Controller

MASON-NEILAN REGULATOR COMPANY

Mason-Neilan Regulator Company, Boston, recently announced the Synchromaster pressure controller, which is a simplified hydraulic-operated combination of pilot mechanism and a diaphragm-actuated control valve of the latest, most advanced design. The unit was developed to improve control and to reduce installation and maintenance costs by eliminating the inconvenience and potential trouble inherent in chains, weights, levers, etc., common to the old-style combination regulator, which incorporated a chain connected balanced valve and hydraulic cylinder. Stable and accurate control is obtained because of the full throttling features of pilot and control valves. The latter is the same valve developed for the exacting requirements of instrument-controlled systems.

Operation is hydraulic, using any external supply of 20 to 150 pounds pressure. Since the pilot bleeds only when control valve diaphragm pressure is reduced, water consumption is low, resulting in economical operation.

The controlled pressure is piped to the pilot valve diaphragm and is balanced by the setting of the springs. Increases or decreases in this pressure move the piston valve to increase or decrease the control valve diaphragm pressure positioning the valve plug to maintain the required pressure in the system. In operation the control valve plug is in a "floating" position, moving only sufficiently to maintain the required flow of the controlled medium.

Pilot construction features include self-aligning spring buttons to prevent binding; thrust ball bearing of stainless steel for easy, accurate spring adjustment; stainless steel ball bearing guides; lap-type piston valve of 18-8 stainless steel; multiple springs for sensitivity and positive action. The pilot may be mounted on wall or panel or directly on the control valve. Control valve features include ball bearing guides; use of 18-8 stainess steel for all parts subject to friction and corrosion; streamlined parabolic centroguide valve plugs; pressure lubricator. Either normally open or normally closed valves may be used.

The Synchromaster Pressure Controller may be used anywhere accurate, positive regulation is required. A variety of standard pressure ranges are available between .1 and 265 pounds. Special ranges up to 750 pounds are also available. Equipment for differential pressure service up to 1500 pounds static pressure may also be furnished.

Blow-Off Valve

HANCOCK VALVE DIVISION

Hancock Valve Division of Manning, Maxwell & Moore, Inc., Bridgeport, Connecticut, announces a full new line of boiler blow-off valves with new "Blo-Deflector" feature.

This new line of Hancock valves incorporates a number of features including the distinctive "Blo-Deflector" protecting lip. The makers claim that this design principle deflects boiler blow so effectively that these new valves are almost indestructible. To further increase the wear-resistance, they

Hancock Blow-off Valve

have stainless steel valve discs hardened to 500 Brinell and renewable valve seat rings heavily Stellited. It is further claimed by the makers that this combination of hard metals reduces maintenance costs to a minimum. Simplicity of design and fewness of parts are other claims made for these valves.

The illustration shows the unique "Blo-Deflector" protecting lip on the 500 Brinell stainless steel valve disc. The makers state that the "Blo-Deflector" side-tracks wear just as a football halfback straight-arms a tackler. In the background is seen a 2-inch straightway type.

These new blow-off valves are made in both straightway and angle types for boiler and economizer pressures up to 1660 pounds, in full compliance with A.S.M.E. code requirements.

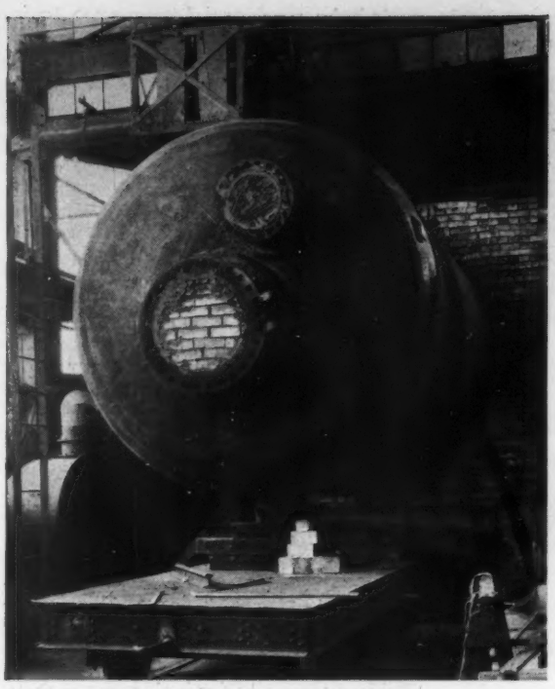
Portable Pyrometer

THE BRISTOL COMPANY

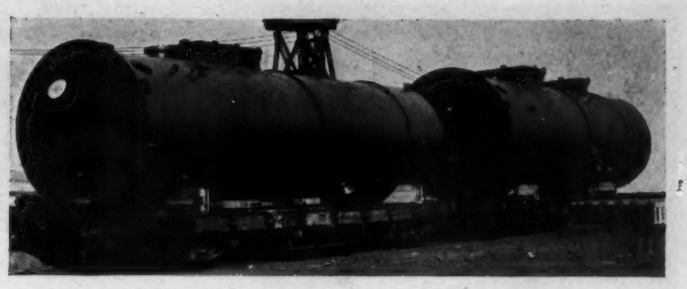
The Bristol Company, Waterbury, Conn., announces a new line of Pyromasters, one of which is a new portable recording pyrometer.

The simple operating principle of these instruments and their compactness of construction, give them special features that are especially useful for portable service. In summary these features are as follows:

The instrument is unusually rugged —not affected by vibration—does not require careful leveling while in use. There are no continuously moving parts or trains of gears to become en-



A.P.I.-A.S.M.E. stress relieving of Class I unfired pressure vessel. The largest oil towers are accommodated with overlap well above the 5-ft. standard specified by the code. Liberal instrumentation and accurate butane-firing of the furnace provide precise control of every phase of each heat.



Class I pressure vessels at plant dock

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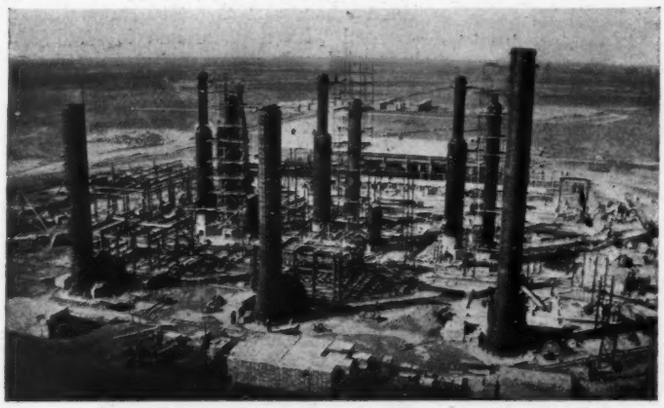

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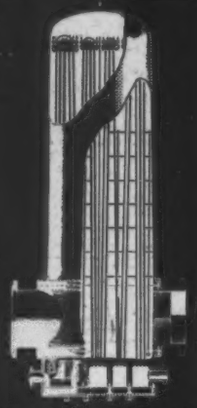

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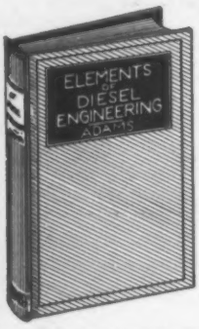

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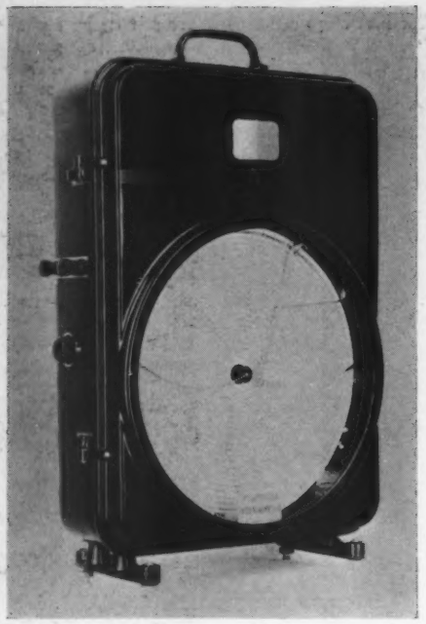


Bristol Portable Pyrometer

gaged and released to position the pen on the chart—no mechanical motion of any kind, except when a change in temperature occurs at the thermocouple.

When an unbalanced condition in the potentiometer circuit occurs, a series of relay-actuated switches operate a motor to position the slide wire contact to which the pen arm is mechanically connected.

The galvanometer is equipped with a highly damped coil—the galvanometer arm is free to deflect at any time.

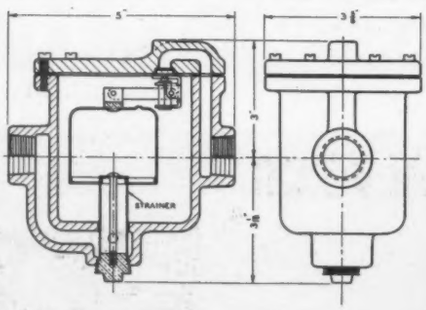
The instrument is constructed so that it is composed of five separate replaceable units—there is no mechanical connection between the galvanometer and any of these units, the connection being electrical only.

Bristol's Portable Pyromasters are available as Pyrometers for ranges from 0 to 500 up to 0 to 3000° F., using standard thermocouples. They are also available as Resistance Thermometers, for ranges from 20 to 350° F. Provision is made on the case for suitable plugging devices to connect these instruments to the thermocouple or resistance bulb, and to a source of a-c power, 110 to 220 volts. The chart is 12 inches in diameter and rotation is by telechron clock.

Inverted Bucket Trap

SARCO COMPANY, INC.

Sarco Company, Inc., 183 Madison Avenue, New York, advise that it has added the new straightway type to its line of inverted bucket steam traps.



Sarco Steam Trap

This trap is known as BM-O and is available in one size with ⅜- or ½-inch inlet and outlet connections. These connections are arranged on opposite sides of the body on the same center line to provide a straight through connection. This arrangement has the advantage of simplifying the pipe connections in a number of installations, particularly in connection with small equipment.

As in all other Sarco inverted-bucket traps, this new type has all the working mechanism attached to the trap cover so that it can be removed by lifting off the cover without disturbing the pipe connections. A Sarco strainer is built right into the trap and no separate strainer is necessary.

Brass Valves

CRANE COMPANY

Crane Company, Chicago, Illinois, announces a new line of brass screwed end globe and check valves for 350 pounds steam pressure at 550°F. These valves are designed especially for high-pressure steam lines. They also may be used on non-shock cold water, oil or gas lines up to 1000 pounds. Their sizes range from ½-inch to 2-inch.

The globe pattern brass valve (62-P) is of the union bonnet design (except the 2-inch which has a bolted bonnet) and has Crane nickel alloy plug-type disc and Exelloy body seat ring. The stuffing box is supplied with a gland and is filled with high-grade packing which may be replen-

No. 9503

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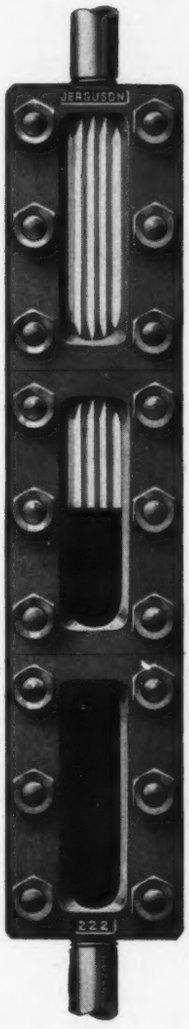

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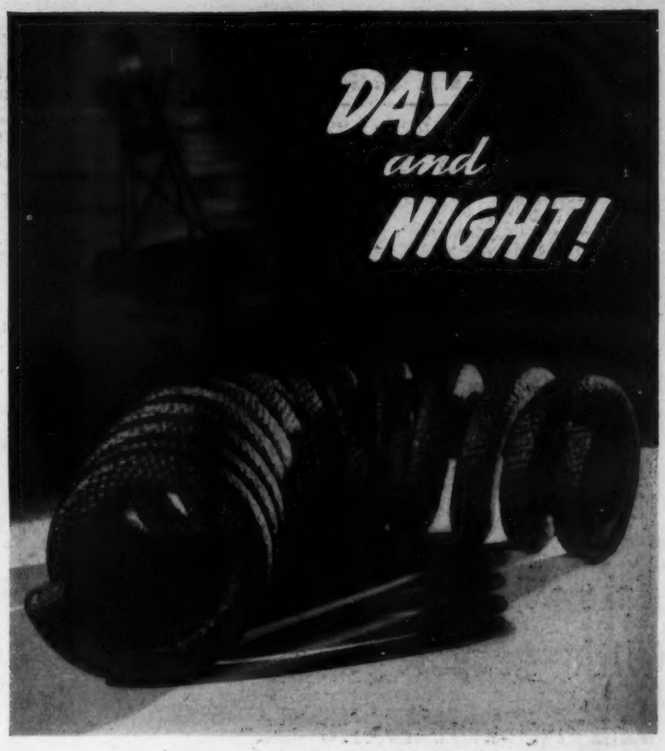

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Month after Month

THE ever-burning light and the ever-tolling bell of the channel buoy are depended upon night and day, through fog or storm, to save lives and cargo. As dependable as the channel buoy is GARLOCK 150 High Pressure Steam Packing. On land and on sea, its reliable quality and long life save time and money by preventing costly shutdowns for frequent re-packing. GARLOCK 150 is recommended for general use against high temperatures and high pressures up to 300 lbs. Try it on piston rods and expansion joints in your plant—you'll like its dependable performance.

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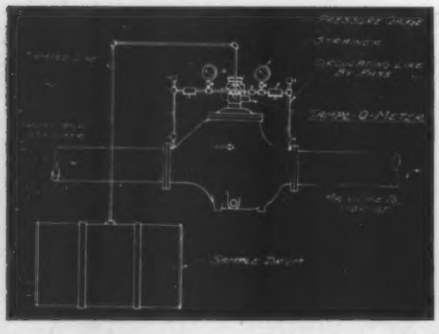

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Associated with Builders Iron Foundry

31 CODDING STREET

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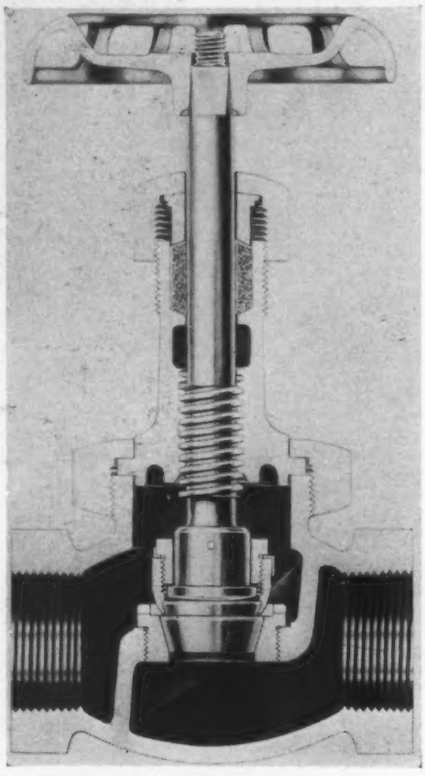
ished when the valve is wide open and under pressure.

The horizontal lift check valve also has a union bonnet except the 2-inch, which has a bolted cap. Discs are of the piston-guided type and seats are renewable screwed in rings of Crane nickel alloy.

Plug-Type Valve Seat

JENKINS BROS.

Jenkins Bros., 822 Washington Boulevard, Chicago, Illinois, have just announced No. 976 Plug-seat valve that features a plug and seat ring made of Jenkins JX500, a stainless steel having a Brinell hardness in excess of 500.



Jenkins No. 976 Plug-Seat Valve

This valve is specially recommended for severe service, such as continuous throttling for pressure reduction or free blow duty, such as soot blowers, injectors, heating coils, or any steam line where close regulation is required.

Burner

WEBSTER ENGINEERING COMPANY

Webster Engineering Company, 419 West 2nd St., Tulsa, announces the Webster VI Series Gas Inspirator which comes after three years of exhaustive laboratory and field tests. The new VI Inspirator is said to have from 30 to 50 percent more capacity per inch size than any other comparable gas burner. It has a reamed mixing throat which produces a greater inspiring effect.

Webster Burner

This increases the velocity of discharge and gives a shorter flame length. A uniform pattern is produced with positive flame direction.

This positive direction of flame eliminates the use of steam to hold the flame from turning up into the tubes due to draft pull. Another feature is the removable spud which can be removed without disconnecting burner piping. This new Webster VI Gas Inspirator is available in a wide range of sizes and capacities. The company manufactures and services a complete line of oil and industrial burners, besides rendering a combustion engineering service from their offices located throughout the United States.

Forged Steel Stop Valve

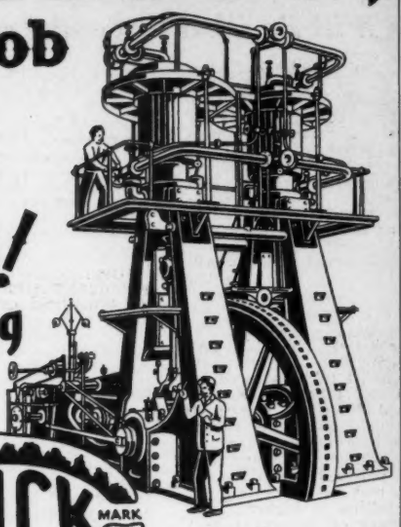
CLEES VALVE & ENGINEERING COMPANY

Clees Valve & Engineering Company, New York, announces a completely new line of stop valves for high-pressure service. These valves are made from a single block of forged steel in sizes from 2½ to 8 inches, and for pressures up to 2500 pounds per square inch. They can be furnished with flanged ends or with ends prepared for any type of welding. They are also made in both angle and offset types and are produced in conformity with A.S.M.E. specifications.

An unusual feature of the off-set valve, which is of the undirectional type, is that its pressure drop approaches that of a gate valve and is considerably less than the drop in other types.

Fractionating Column 71 feet long by 9 feet in diameter, leaving the stress-relieving furnace at Birmingham, Alabama works of Chicago Bridge & Iron Company. The column was fabricated, x-rayed and stress relieved at this plant before shipment for installation at a Bayway, New Jersey refinery.

Built 1886, on the job 51 years!



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TRADE FRICK MARK

Refrigeration

When a Frick Compressor of the type shown was dismantled in Baltimore, Md., recently, it had completed over half a century of service—probably a world's record for refrigerating equipment.

Scores of other Frick machines, installed 40 to 50 years ago, are still going strong. And 35,000 enthusiastic owners attest the progress made with Frick Refrigeration since these old timers set the pace.

Modern Refrigerating Compressor with same capacity as gigantic machine shown above.

Dependable and economical sub-zero temperatures are assured for process, test, or research work, when you specify "Frick."

DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA. U.S.A.

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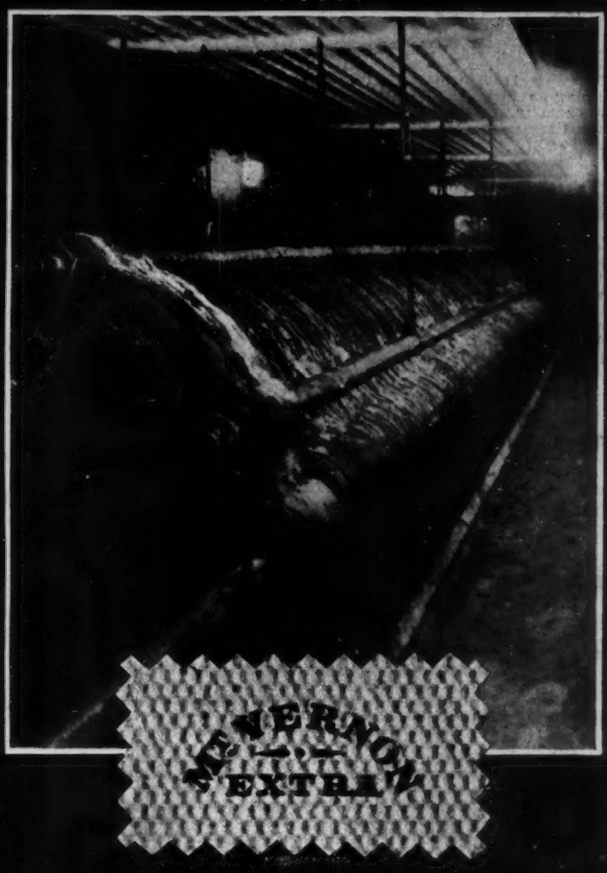

Precision Fabrics

• When maximum efficiency in each filtration process depends so largely upon the uniformity of the filter fabric used, it pays to give the greatest possible care to fabric selection.

Every square inch of all MT. VERNON EXTRA fabrics tests to such a remarkable degree of uniformity with every square inch of the same construction, that they may justly be called precision fabrics. Woven on the finest of modern looms from yarns tested to micrometric tolerances, their whole production is guided by more than half a century's experience.

To secure maximum efficiency in each filtration process first determine what construction is best adapted to that particular need, then specify it — MT. VERNON EXTRA.

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CATALOGS . . . BULLETINS

Helpful Publications Which Manufacturers Will Be Glad to Send Free for the Asking

Turbine-Generators

Allis Chalmers Manufacturing Company, Milwaukee, Wis., has published a 28-page bulletin, No. 1180, which covers condensing reaction-type turbine generators of 1500 to 5000 kw capacity. Photographs and drawings illustrate the separation of oil and steam piping to eliminate possibility of oil fires, new combined journal and Kingsbury thrust bearings, separate steam chest, four-bearing construction of governing system. Both turbine and generator construction is presented in detail.

Pressure Governors

General Electric Company, Schenectady, New York, is distributing a catalog sheet on pressure governors for use with automatic starters for AC and DC motor-driven pump or compressor, to maintain constant pressure between set limits on liquid or gas systems. Tables and charts show rating and connections.

Monel Metal

The International Nickel Company, Development and Research Division, 67 Wall St., New York, is distributing a 16-page technical bulletin, T-9, of which 11 pages present technical data on the engineering properties of "K" Monel, including physical constants, properties, information on hot and cold working, heat treatment, shop working, welding and soldering. The remaining five pages discusses applications.

Flexible Couplings

Ajax Flexible Coupling Company, Westfield, New York, has published a 16-page catalog which is well illustrated with blue-print type of drawings, and which gives complete specifications and data on all types of flexible couplings manufactured by the company.

Belts

The Manhattan Rubber Manufacturing Division of Raybestos-Manhattan, Inc., Passaic, New Jersey, has issued a new illustrated four-page bulletin on Condor Compensated Belts. In addition to describing the reason for compensating rubber belts and the compensated principle, the new folder explains in detail the advantages of this type of belt. Engineering data essential to the proper selection, application and supervision of belts is also included.

Castings

Vanadium Corporation of America, 420 Lexington Ave., New York, has published a new 24-page bulletin, which contains a complete description of the properties and applications of a number of vanadium alloy steels for castings where high strength is required without excessive weight or high cost. The booklet is well illustrated with more than 20 photographs of various types of high-strength castings. Among the alloy steels discussed are carbon-vanadium steel, manganese-vanadium steel, nickel-vanadium steel and nitriding cast steel. Heat treatment is discussed from the standpoint of obtaining greatest effectiveness from these types of castings. Recommended uses for these different alloy steels are given. A complete section is devoted to specifications of carbon-vanadium, manganese-vanadium and nickel-vanadium alloy steels. The specifications include the process by which the steel is made, the normalizing and tempering procedure, chemical properties and tests, physical properties and tests, workmanship and finish, marking and inspection.

Steam Purifiers

The Cochrane Corporation, Philadelphia, Pa., is distributing Publication No. 2725 which is a presentation of the benefits to be secured by the installation of a purifier to eliminate damage that may be caused by the presence of moisture and solid impurities in the steam. It describes specifically how expensive equipment, such as turbines, engines or pumps may be saved from being wrecked by slugs of water; how superheaters may be protected from sludge and moisture, resulting in higher steam temperature without danger of burning tubes; how to improve the efficiency of prime movers by reducing steam consumption and driving boilers at higher ratings. Construction details and styles of Cochrane Purifiers to satisfy individual piping layouts complete the contents of this 12-page booklet.

Metal Spray

Metalspray Company, Inc., 113 Llewellyn Street, Los Angeles, California, has published Bulletin 800, describing some of the new applications in metal spraying. A wide variety of applications is illustrated and briefly described, most of which involve new methods. Complete records of procedures and costs are available to anyone desiring further details concerning any of the subjects illustrated.

Measuring Instruments

The Brown Instrument Company, division of Minneapolis-Honeywell Regulator Company, Philadelphia, Pennsylvania, describes and illustrates in a recent bulletin various types of recording, indicating and controlling equipment. This bulletin, No. 1102, is illustrated and contains data on the application of the equipment to various problems.

Pressure Regulators

Grove Regulator Company, 1729 Poplar Street, Oakland, California, recently published two new bulletins No. 1001-B and G-1, describing types of pressure regulators for oil, gas and air.

Compressors

Chicago Pneumatic Tool Company, 6 East 44th Street, New York, recently published bulletin No. 762, which describes portable and stationary Diesel engine-driven compressors. This brochure is illustrated and contains data as to the operation and capacity of the equipment.

Motors

General Electric Company, Schenectady, N.Y., has published "Vertical Hollow-Shaft Induction Motors" which describes in detail the construction design and operation of these motors. Line drawings and photographs show details of assembly and construction.

Pumps

Fairbanks, Morse & Company, Chicago, is distributing Bulletin 6285 which describes the new duplex steam pumps of eight cover side pot type fluid end and improved piston valve steam end. All pertinent engineering information is included in the text and accompanied by photographs and line drawings showing design and construction.

Steam Traps

V. D. Anderson Company, Cleveland, Ohio, is distributing new literature describing a new drop forged steel steam trap which is said to incorporate all of the features of the regular modern Anderson Super-Silvertop, and averages 122 percent greater condensate capacity than the previous models of forged steel traps.

Paint

Pennsylvania Salt Manufacturing Company, 1000 Widener Building, Philadelphia, is distributing new literature covering the recently developed line of Penn Paints, manufactured by this company. Its success in combating corrosion is described as its paint coverage application to iron and steel and concrete, and other outstanding characteristics.

Air Conditioning

Frick Company, Waynesboro, Pa., is distributing new bulletins describing low pressure compressors for freon 12, or methyl chloride, a low pressure unit for air conditioning, which units are of three different types and are covered in three separate pieces of literature.

Automatic Switches

The Automatic Switch Company, 154 Grand St., New York, has issued a small text book, "Controlling Valves Electrically" which covers that company's line of automatic switches of the solenoid type.

Regulators

Northern Equipment Company, Erie, Pa., has published Bulletin No. 409-A, covering the Copes Flowmatic Regulator which feeds boilers automatically according to steam flow. Details of the apparatus are shown dealing with design, operation and installation and all pertinent engineering information is included in the text.

Centrifuge

Sharples Specialty Company, 23rd and Westmoreland Streets, Philadelphia, has issued a new and highly interesting and informative bulletin covering the Sharples Ulta-Centrifuge, which is classed as a highly important new research tool. The 80,000 r.p.m. machine is described and its operation discussed, and its design and construction is shown by drawings and photographs.

Pumps

Dayton-Dowd Company, Quincy, Illinois, has published bulletin 805, describing that company's line of centrifugal pumps for hot and cold water circulation, brine circulation, oils and gasoline, acids and chemicals, air washes, refrigeration machines and general industrial services.

Steam Traps

Sarco Company, Inc., 183 Madison Ave., New York, has published "Steam Hook-Ups" as a new handbook which will prove of value. The book covers methods for calculating trap sizes, hook-ups and descriptions of various types of heating systems, including unit heaters and air conditioners, hook-ups for process steam applications, for steam headers, and for temperature control, and basic descriptions of the fundamental characteristics of the various types of steam traps, temperature regulators and steam accessories required.

Electrical Instruments

James G. Biddle Company, 1211 Arch Street, Philadelphia, has issued several new booklets of value. Bulletin No. 1535 describes an Improved OHM Scale for Meg and Super Meg Insulation Testers; Bulletin 1540 describes Meggar direct-reading Ohmmeters and Bulletin 1545 describes the Midget Meggar Tester for testing electrical insulation resistance.

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